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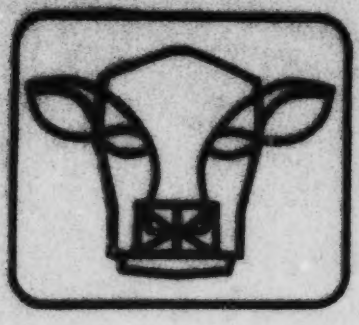

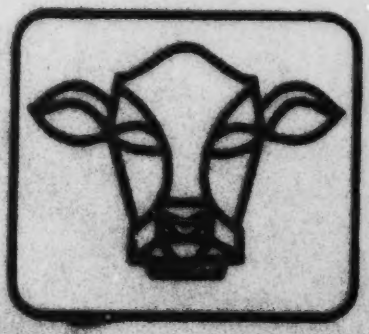

1984 MANITOBA ANIMAL INDUSTRY CONFERENCE PROCEEDINGS

A Forum for Professionals in Animal Agriculture

Manitoba Agriculture

ANIMAL INDUSTRY CONFERENCE

A FORUM FOR PROFESSIONALS

Thursday, December 11, 1984

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FOREWORD

The Manitoba Animal Industry Conference was established in 1978 to meet three basic needs for professionals in animal agriculture:

1. To enable individuals in research, extension and agri-business to become better acquainted with projects, programs and activities of those in other sectors.

2. To disseminate information, often in the form of research results on timely topics.

3. To serve as a forum for presenting the problems confronting animal agriculture and for discussing possible solutions.

The 1984 program covered a wide range of thought-provoking, informative topics and provided those in attendance with ample food for thought and discussion.

Norm Hemstad
Chairman, Planning Committee

Committee Members:

Norm Hemstad, Manitoba Agriculture

Bruce Campbell, Regal Feeds Ltd.

Gary Crowe, University of Manitoba

Bill Garbowsky, Manitoba Agriculture

Dr. Dennis Hacker, Manitoba Agriculture

Kate Harrison, Manitoba Agriculture

Rob McNabb, Manitoba Agriculture

Tony va Rosmalen, Agriculture Canada

ESTRUMATE

'CONTROLLED BREEDING IN THE BEEF HERD WITH BULLS'

By Peter Crowe-Swords

INTRODUCTION

ESTRUMATE has been commercially available to the Canadian beef industry since the fall of 1977. It is probably fair to say that Controlled Breeding programs with artificial insemination have been slow in being accepted by the commercial beef producer. One reason for this could well be producer opinion that sires available through artificial insemination are not necessarily that much superior to the bulls which he can buy. In general, where controlled breeding programs with artificial insemination have been used, the producer has been satisfied. He has been able to select a program to fit his needs and make the necessary management and animal adjustments to attain success.

Controlled breeding programs have shown considerable long term advantages, such as, concentration of the calf crop and reduction in the calving season. It is with these benefits in mind, that an increasing number of producers have considered the possibility of using bulls with controlled breeding programs. Initially, the majority of the interest came from the purebred beef producer, but, more recently, a large number of requests have come from large commercial ranches in Western Canada.

The producer who plans to use controlled breeding programs with bulls will have to consider his short and long term goals, bull evaluation, cow selection and management requirements.

PRODUCER GOALS

CONSOLIDATED CALVING SEASON - The calving season can be consolidated by using controlled breeding with bulls. ICI research has demonstrated a substantial increase in the number of calves born in the early part of the calving season. In three herds used on the ICI study, the number of calves born in the first ten days of the calving season was 35% for the treated group compared to 15% for the control group (Table 1). By completion of 30 days of the calving season 74% of the treated group had calved compared to 68% of the control group.

INCREASED HERD PREGNANCY - The beef producer can also expect to increase herd pregnancy rates with controlled breeding programs. By injecting ESTRUMATE at the start of the breeding season the producer can expect to triple the number of animals bred in the first week of the breeding season. This also will result in an increase in the total number of exposures each cow has to the bulls during the breeding season. The net result will be an increased herd pregnancy rate. With the same three experimental herds mentioned above (Table 1), the average herd pregnancy rate was 84% and 87% for the control and treated groups respectively.

REDUCTION OF TIME SPENT CALVING - One of the major tasks the cattleman has in the spring of the year is to calve out his heifers. Heifers require considerable attention during the calving season and at times need assistance. For many producers this involves long working days, as well as checking the heifers at night. By the end of the calving season fatigue has often set in and calves are lost through inattention.

The calving season can be reduced in length by reducing the breeding season. Unfortunately, this often results in a reduction in the herd pregnancy rate. By injecting ESTRUMATE at the start of the breeding season and shortening the breeding season by 15-20 days the same pregnancy rate can be obtained, and the calving season will also be reduced.

This has been demonstrated on a herd in British Columbia where a group of 230 heifers were assigned equally to an untreated control group and an ESTRUMATE treated group. The bulls were exposed to the heifers for only 26 days. The pregnancy diagnosis in the fall of the year showed 61% of the control group and 74% of the treated group pregnant to this shortened breeding season. In previous years a 45 day breeding season was required to obtain a 75% pregnancy rate.

INCREASED WEANING WEIGHTS - The combination of consolidated calving and increased herd pregnancy rates will lead to increased weaning weights. In herds where weaning weights have been measured, the number of pounds of calf weaned per cow exposed has increased by approximately 13 pounds per cow.

PRODUCE A MORE UNIFORM CALF CROP - Since the calving season will be consolidated with controlled breeding programs, the selection of replacement heifers will be easier. That is, a larger number of heifers will have met the age and weight requirements for breeding as yearlings.

Calves going to sales will be of more uniform age and size in the fall of the year and should command a premium price on the market.

POTENTIAL FOR REDUCING THE NUMBER OF BULLS - The increased number of cows which can be bred in the first 5 days of a controlled breeding season may facilitate intensive breeding pasture management. Traditionally, when cows are at range the bull to cow ratio would be 1:20 or 1:25. If the synchronized cow herd was placed in a confined breeding pasture for the first week of the breeding season the bull to cow ratio could be increased, thus reducing the number of bulls required. This would allow the beef producer to decrease his bull investment costs or buy fewer better quality bulls.

SYNCHRONIZE GROUPS OF COWS TO A SINGLE BULL - It is possible to increase the total number of cows bred to a single bull with controlled breeding. Groups of cows could be synchronized at 2 week intervals during the breeding season, using the same bull to breed each group of cows. As many as 100 cows could be exposed to a single bull in 2 months.

POTENTIAL PROGRAMS

Prostaglandins are effective in the control of breeding times because they shorten the life span of the corpus luteum (C.L.). Therefore, if an ESTRUMATE injection was given to a randomly cycling group of cattle, one would expect to have approximately 70-80% of those cows in heat within five days. This would include the cows responding to ESTRUMATE which had C.L.'s and those cows coming into heat themselves.

What injection program to use for controlled breeding with bulls depends on the management which exists in the producers herd. Experience has shown that the commercial cattleman does not like to handle his cows

too often. It is with this in mind that the recommendation would be to use single injection programs.

PROGRAM D - This program gained rapid popularity with artificial insemination programs due to the ability to maximize the cows showing heat while limiting the doses of ESTRUMATE used. Program D (Figure 1), can be used with bulls, and result in 80-90% of a group of cows being bred in ten days.

The program works like this. On day one of the program, bulls with marker devices are placed with a group of cows. By day six of the program, approximately 20% to 25% of the group of cows should be marked by the bulls. Any cows which have not been marked by this time are injected with ESTRUMATE. By the completion of day ten approximately 80-90% of the cows should have been marked and therefore bred. The marker devices should be removed at this time and the breeding season continued as per normal practice.

PROGRAM B - This injection regime would seem to offer the most advantages to the beef producer. It calls for a single injection of ESTRUMATE on day one of the breeding season (Figure 1) and bulls placed with the cows on the same day. Provided the cattle are in good condition and cycling normally, approximately 70-80% of the animals injected should be bred in the first five days of the program. Once again, marker devices can be used by the producer to establish which cows have been bred in the first five days of the program. As with Program D the normal breeding season continues following this controlled breeding program.

SHOULD COWS BE PALPATED? - The veterinarian can reduce the number of ESTRUMATE doses used on controlled breeding programs. If rectal palpation was used on day 6 of Program D, the number of ESTRUMATE doses could be reduced by approximately 20%, by injecting only cows which have C.L.'s.

By rectal palpation on day 1 of Program B, the number of ESTRUMATE doses could be reduced approximately 40% by injecting only cows which have C.L.'s.

Of equal importance on both programs, rectal palpation reduces the chance of program failure, since the veterinarian has the opportunity to establish herd cyclicity before prostaglandin injections are given.

COW SELECTION

The producer can match a program to fit his particular needs and objectives and can obtain significant benefits. It is important to remember that there are considerable animal requirements for success of a controlled breeding program.

HERD CYCLICITY - It has been demonstrated by many research workers that anestrus exists as a significant factor in beef herds in North America. Wenkoff et al (1), have demonstrated how herd cyclicity affects controlled breeding programs. Over the five years of the study the number of anestrus cows at the start of the breeding season ranged from a

high of 39% to a low of 11%. If all these anestrus cows were a part of a controlled breeding program, the prostaglandin response would be reduced considerably.

AGE EFFECT - The effect of age of cow on a controlled breeding program was also demonstrated by Wenkoff (2). Three year old cows (Table 2) had the highest level of anestrus, at 48%. Further studies reported by ICI (2) have shown that two and three year olds generally show the highest level of anestrus. The veterinarian should caution the producer on entering these young cows on a controlled breeding program without assessing their cyclicity.

POST-PARTUM EFFECT - Cows with less than 50 days post-partum interval have lower levels of cyclicity and first service conception rate than those in excess of 50 days.

The data accumulated from one of ICI's bull breeding studies (Table 3) shows that for cows with less than 30 days post-partum rest, only 25% were bred in the first 4 days of the breeding season. For cows with 30-50 days post-partum interval, 60% were bred in the first 4 days of the breeding season and for cows with 50 or more days post-partum interval, 76% were bred in the first 4 days of the breeding season. Consideration should be given to using 50 days as the minimum post-partum interval for cows on a controlled breeding program.

HEIFER MATURITY - Heifers must have reached target weight and age before being considered for controlled breeding. Puberty is reached at a different age and weight, depending on the breed. Angus for example, would need to be 650 pounds at the start of the breeding season as compared to Chianina crossbreds at 800 pounds. The subject of controlled breeding in heifers has been covered in detail (3).

NORMAL, HEALTHY REPRODUCTIVE TRACTS - Animals must be non-pregnant as prostaglandins are potent abortifacients. They must also be free from any diseases which could affect reproduction.

BULL SELECTION

BREEDING SOUNDNESS EVALUATION - Seminal characteristics which have been evaluated for the breeding soundness examination (B.S.E.) of bulls have included spermatozoal motility, morphology and concentration as well as an estimate of the percentage of live spermatozoa (live:dead ratio). Recently, scrotal circumference measurement was added to the list. Some criteria are less reliable and less related to fertility than others. This caused the Society of Theriogenology (4) to recently revise their recommended scoring system to comprise those measurements considered to be of greatest value; scrotal circumference, spermatozoal morphology and spermatozoal motility (Table 4).

With this system, a bull with a composite score between 60 and 100 is satisfactory, a score between 30 and 59 is questionable and a score of less than 30 is unsatisfactory. Bulls with a BSE score less than 60 should not be considered for controlled breeding programs.

LIBIDO SCORE - The assessment of libido and mating ability in bulls is important because it can help in the detection of physical abnormalities. The genetic basis of libido and mating ability in the bovine has been well proven and it has been shown that bulls vary considerably in their inherent reproductive capabilities. By the evaluation of libido bulls with increased mating ability will be able to be selected. A serving capacity test developed by Blockey (5), where non-estrus cows were placed in service crates and bulls exposed to these cows for a one hour period. The number of services performed by each bull is recorded. Bulls with a high service capacity test serviced more heifers in a three week breeding season. Blockey has also shown a strong relationship between serving capacity and pregnancy rates (Table 5).

More recently Farin (6) described a modified libido-serving capacity test which reduces the time required from 1 hour to 10 minutes. The prodcedure is as follows: "Two non-estrus heifers were first prepared by administering an intra-muscular injection of 20 mg of Rompun. Each heifer was haltered and restrained in 1 of 2 service crates (Figure 2 and 3) which were separated from each other by approximately 8 metres. Bulls were subjected to a prestimulation before being tested. This was accomplished by allowing them to observe the sexual activity of bulls exposed to the restrained heifers in an adjacent pen for at least 10 minutes. Two bulls to be tested were then admitted into the pen with the restrained heifers and their sexual activity was recorded for 10 minutes."

At the end of the test period, each bull received a libido score (Table 6) based on 0 (No sexual interest) to 10 (2 services followed by sexual interest, mounts or further services) as described by Chenoweth (7). The shorter test period, i.e. 10 minutes has shown to be a satisfactory indicator of serving capacity.

BULL TO COW RATIO - In recent years, a number of researchers have addressed the subject of bull to cow ratio (B.C.R.) in conventional breeding programs. The traditional B.C.R. ratio for a commercial ranch in Western Canada would be in the range of 1:20 to 1:30. Rupp (8) has demonstrated that a B.C.R. of 1:60 is satisfactory, provided superior bulls are selected and used properly. Farin et al (6), conducted a number of synchronization studies using bulls. He obtained satisfactory conception rates with a B.C.R. of 1:20 and 2:40. Both of the above researchers have pointed out that an increased B.C.R. can be used provided the bull has a satisfactory breeding soundness examination (B.S.E.) and superior libido.

CONTROLLED BREEDING STUDIES - The objective of the study was to evaluate the concept of controlled breeding with bulls. The study was designed to look at the benefits of controlled breeding over the long term, as well as identifying the bull evaluation requirements for success, e.g. B.S.E. scores, libido scores and bull to female ratio.

As part of a controlled breeding study, bulls which have been evaluated for breeding soundness and libido were put in with one of two

groups of cows, 110 controls and 115 cows treated with ESTRUMATE on day one of the breeding season (Program B). Each group was kept separate for 4 days. At this time both groups were placed in a single pasture. The bull evaluations can be seen in Table 7. All bulls had a minimum scrotal circumference of 35 cm. and all bulls had a satisfactory breeding soundness examination (B.S.E.). Bulls used on the study had a minimum libido score of 9, which means they had two or more services during the ten minute test period. The libido score is multiplied by ten and added to the B.S.E. score to give a combined score or Bull Index. As one can see the highest bull index was 200 (maximum points) for bull number 1 in the treated group and the lowest bull index was 164 for bull number 10, also in the treated group.

This bull index system allows for equal emphasis to be placed on breeding soundness evaluation and libido scores.

Bulls were fitted with chin-ball markers with different colour paint to identify which bulls serviced which cows in the first 4 days of the breeding program. The bulls with the highest libido, B.S.E. and bull index generally serviced a higher percentage of cows in each group. It would also be surprising to a large number of people to see the numbers of cows serviced in the first 4 days by the bulls on the treated group.

All calves born in the first 40 days the following spring were blood typed to assess parentage. Although there is considerable variation between bulls in the two groups, probably due to bull dominance during the breeding season, the added pressure put on the treated group bulls did not adversely affect conception.

The breeding field activity of bulls has been recorded in a total of 3 herds to date. As one can see from Table 8, bulls are capable of breeding a large number of synchronized cows in a relatively short period of time. It does not depend on bull maturity, yearlings can breed as many cows, and in some cases more than 4 or 5 year olds. This can be seen from the example in Herd C.

In these experimental herds, the number of cows bred in the treated group was considerably higher than was bred in the control group in the first four days of the breeding season, Table 9. In Herd A, 22% of the controls were bred in the first four days as compared to 56% of the treated cows. In Herd B, 44% of the controls were bred in the first four days as compared
to 70% in the treated group. In Herd C 16% of the controls were bred in the first four days as compared to 66% in the treated group.

We can therefore say that in selecting bulls for a controlled breeding program, it is important to have a breeding soundness exam and libido score. Provided satisfactory results are obtained from both tests the average bull can be used on a controlled breeding program with a bull to cow ratio of 1:20 or 1:25.

SUMMARY

BENEFITS - Controlled breeding programs with bulls can consolidate calving interval, increase weaning weights, increase herd pregnancy

rates and have the potential of generating a larger number of calves of more uniform age and size.

PROGRAMS - Program B whereby cycling animals are injected once with ESTRUMATE at the start of the breeding season would seem to have the greatest potential for the majority of commercial beef producers.

COW SELECTION - Proper selection of cows for a controlled breeding program is essential for success. Cows need to be on adequate nutritional levels to have high percentage cycling at the start of the breeding season. Younger cows, that is, two and three year olds have a history of lower cycling percentages at the start of the breeding season and may be considered ineligible for a controlled breeding program. Consideration needs to be given to the breed or cross-breed being used for a breeding program. Heifers in particular may need to have a higher weight and older age at the start of the breeding season if they have large amount of European genetics in them.

BULL EVALUATION - Where breeding soundness examinations and libido tests are used, a bull to cow ratio of 1-25 would seem to be adequate for a controlled breeding program. In the future, as more data is generated by research it may be possible to increase the bull to female ration on controlled breeding.

REFERENCES

1. Wenkoff, M., Crowe-Swords, P.R. The Management of Prostaglandin - Controlled Breeding Programs in Beef Cattle - A Five Year Study. Can. Vet. J. Vol. 24: P.50, 1983.

2. Controlled Breeding in the Beef Herd. ICI Pharma, Infovet Vol. 1, No. 3, 1983.

3. Controlled Breeding in Heifers. ICI Pharma, Beef Management Update. Vol. 1, No. 2, 1983.

4. Manual for Breeding Soundness Examination of Bulls. J. Soc. for Theriogenology Vol. 12:1, 1983.

5. Blockey, M.N.D. The Bull Book. A technical manual on the examination of bulls for breeding soundness. Pastoral Research Institute, Hamilton, Victoria, Australia.

6. Farin, P.W., Chenoweth, P.J., Mateos, E.R., Pexton, J.E., Beef Bulls Mated to Estrus Synchronized Heifers; Single vs. Multi-sire Breeding Groups. Theriogenology J., Vol. 17: No. 4: P.365, 1982.

7. Chenoweth, P.J. Consideration of behavioral aspects of the natural breeding bulls. Proc. Ann. Meeting. Soc. for Theriogenology, Lexington, Kentucky. P.109, 1976.

8. Rupp, G.P., Ball, L., Shoop, M.C., Chenoweth, P.J., Reproductive efficiency of bulls in natural service: effects of male to female ratio and single vs. multiple-sire breeding groups. J. Am. Vet. Med. Assn. Vol. 171: P.639, 1977.

TABLE 1

EFFECT OF A SINGLE INJECTION ESTRUMATE® CONTROLLED BREEDING PROGRAM WITH BULL ON CALVING PATTERN

	CONTROL				TREATED			
COWS IN GROUP	HERD 'A' 24	HERD 'B' 112	HERD 'C' 21	TOTAL 157	HERD 'A' 22	HERD 'B' 115	HERD 'C' 23	TOTAL 160
CALVES BORN								
DAY 1 - 10	?	19%	10%	15%	50%	30%	35%	35%
DAY 1 - 20	58%	72%	57%	68%	68%	75%	74%	74%
TOTAL CALVED	71%	89%	71%	84%	73%	90%	87%	87%

ICI Data

TABLE 2

EFFECT OF COW AGE ON CYCLICITY AND CONCEPTION RATES

AGE (YEARS)	NUMBER AVAILABLE (1978-1980)	ANESTRUS[a] %	NUMBER[b] BRED	PREGNANT %
3	73	48[c]	38	58
4	99	27[c]	72	58
5	70	16[c]	59	61
6 and 7	176	21[c]	139	57
8 and over	72	19[c]	58	55

[a] Based on rectal palpation.

[b] Synchronized with cloprostenol and fixed time bred 74-85 hours later.

[c] Percent anestrus by age with superscripts not in common are different ($P < 0.05$)

Wenkoff et el., 1983.

TABLE 3

THE EFFECT OF POST-PARTUM INTERVAL ON THE NUMBER OF COWS BRED IN THE FIRST 4 DAYS OF A CONTROLLED BREEDING PROGRAM WITH BULLS

DAYS POST-PARTUM	NUMBER AVAILABLE	NUMBER BRED	PERCENT BRED FIRST 4 DAYS
< 30 Days	12	3	25%
30 - 50 Days	5	3	60%
50 > Days	76	58	76%

ICI Data

TABLE 4

BREEDING SOUNDNESS SCORING SYSTEM FOR BULLS

CLASSIFICATION	MOTILITY	MORPHOLOGY	SCROTAL CIRCUMFERENCE	SCORE
Very Good	20	40	40	100
Good	12	24	24	60
Fair	10	10	10	30
Poor	3	3	10	16

Society for Theriogenology, 1976.

TABLE 5

RELATIONSHIP BETWEEN A BULL'S SERVING CAPACITY AND HERD FERTILITY

SERVING CAPACITY (40 MIN. TEST)	FIRST SERVICE CONCEPTION (%)	PREGNANCY RATE (%)
0, 1 or 2	4 - 40	4 - 67
3, 4 or 5	55 - 65	89 - 93
6 to 11	62 - 78	90 - 100

Blockey.

TABLE 6

L I B I D O T E S T I N G S C O R E S

0 - No interest

1 - Interest on one occasion only

2 - Interest on more than one occasion

3 - Active interest throughout test

4 - One mount or attempt. No service.

5 - Two mounts or attempts. No service.

6 - More than two mounts or attempts. No service.

7 - One service no further interest.

8 - One service followed by interest.

9 - Two services. No further interest.

10 - Two services followed by interest (including mounts and/or services).

Chenoweth: 1976.

PRE-BREEDING BULL EVALUATIONS COMPARED TO FIELD ACTIVITY ON A CONTROLLED BREEDING PROGRAM USING BULLS

GROUP	BULL NO.	SCROTAL CIRCUMFERENCE	BSE SCORE	LIBIDO SCORE	BULL INDEX	NUMBER COWS SERVICED FIRST 4 DAYS	CALVES SIRED FIRST 40 DAYS OF CALVING
CONTROL (110 COWS)	2	36.5	84	10	184	13	20
	4	36.0	84	9	174	3	10
	5	36.5	84	9	174	8	19
	8	37.0	68	10	168	3	13
	9	35.5	76	9	168	3	5
TREATED (115 COWS)	1	40.0	100	10	200	18	19
	3	35.0	84	10	184	24	12
	6	37.0	76	10	174	35	6
	7	36.0	68	10	168	12	8
	10	37.0	74	9	164	12	3

ICI DATA: GUICHON '82

TABLE 8

NUMBER OF COWS BRED BY EACH BULL

FOR THE FIRST 4 DAYS OF CONTROLLED BREEDING

PROGRAMS WITH BULLS

HERD	BULL	AGE	COWS BRED FIRST 4 DAYS
A	1	7	18
	2	3	24
	3	3	35
	4	3	12
	5	3	12
B	6	3	49
	7	3	39
	8	3	48
	9	3	42
C	10	5	19
	11	5	11
	12	1	21
	13	1	30

TABLE 9

CONTROLLED BREEDING WITH BULLS:

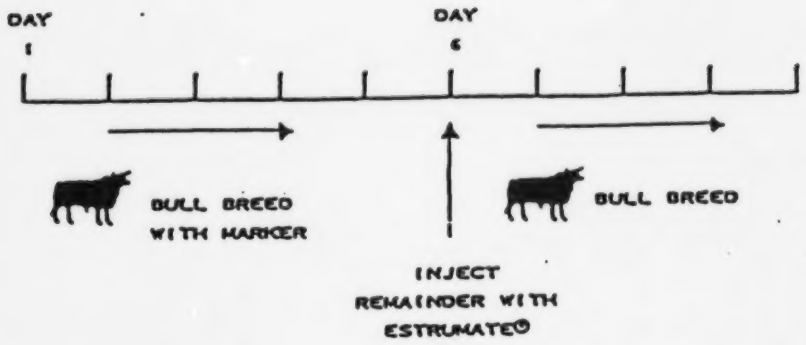
PERCENT OF COWS BRED BY DAY 4 OF BREEDING SEASON

HERD	CONTROL GROUPS	TREATED GROUPS
A	22%	56%
B	44%	70%
C	16%	66%

ICI Data

FIGURE 1

PROGRAM D (WITH NATURAL SERVICE)



PROGRAM B (WITH NATURAL SERVICE)

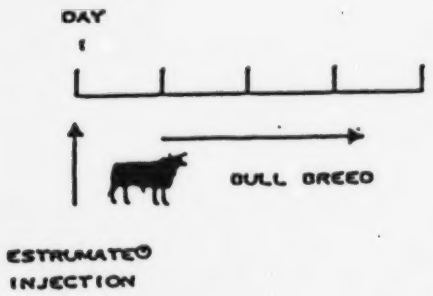


FIGURE 2

Service crate for libido test. In this example a Pearson head gate has been used. The internal dimensions are 40" front to back and 28" side to side.

FIGURE 3

Two non-estrus heifers are placed in service crates 8 metres apart.

COMPUDOSE (R) - A NEW GROWTH IMPLANT

by Bruce Mitscke, Animal Health Representative, Elanco

The serious Elanco commitment to Animal Agriculture is not a recent one ... dating as it does from the discovery of Tylosin a quarter of a century ago.

Elanco, in 1977, reached the feedlot market in both Western Canada and Eastern Canada with Rumensin, a product you know well, one that has made a real contribution to the Canadian beef production industry in recent years.

Progressive beef production managers employ every "tool" that can contribute to production efficiency. And that includes implants.

Now, out of Elanco research, comes a new implant, the result of a major breakthrough in implant technology.

This is the controlled release implant! Compudose! The role of growth promotants is to improve production efficiency through increased animal efficiency, whether the result is measured in increased gain per unit of feed, or equal on less feed.

THE ACTIVITY OF ANABOLIC COMPOUNDS, is to promote "constructive metabolism" within the animal's body that results in an increase in protein deposition, which means an increase in the production of lean meat.

Low levels of an estrogenic substance such as the anabolic agent estradiol-17B increases pituitary size ... increases secretion of growth hormone ... and increases the production of lean meat.

Estradiol-17B, a naturally occurring estrogen, is produced by the ovarian follicles in mammals.

In contrast, synthetic estrogen does not occur naturally in cattle - one example is zeranol or Ralgro.

Considering the amount of estrogen produced by the human body each

day, the additional estrogen in 500 grams (1.10 lbs.) of beef from a Compudose treated steer is minute. It's about 0.0001 to 0.0012% of the total estrogen produced by a child each day.

COMPUDOSE ... A TOTALLY NEW DELIVERY SYSTEM. Controlled release Compudose implants are cylindrical cores of silicone rubber covered with a thin white coating of estradiol medicated rubber.

The implant is a 3 cm (about 1.18 inches) long cylinder. with a diameter of 4.76 mm (3/16 inch).

The implant contains 24 mg of estradiol-17B, designed for continuous release for an extended period of time.

The inner core of the cylinder is made of unmedicated silocone rubber.

This delivery system provides for daily controlled release of estradiol into the steer's body.

After subcutaneous implanting of Compudose, the estradiol in molecular form feeds out from the surface of the implant and into the animal's extracellular fluid.

The estradiol crystals in the matrix dissolve slowly. The silicone rubber serves as a reservoir for the gradual release of additional molecules of estradiol as required.

This unique controlled-release delivery system ensures maximum hormonal response from a minimum dosage of estradiol-17B ... gradual release for a period of at least 200 days, 2 to 3 times longer than existing implants. Compudose stretches performance.

WITH COMPUDOSE ... AVERAGE DAILY GAIN AND FEED EFFICIENCY ARE IMPROVED. Canadian and American field trials report average daily gain increases 12.7% and 17.4% ... and improved feed efficiency of 6.4% and 7.4% respectively.

WITH COMPUDOSE ... THERE'S NO NEED TO REIMPLANT YOUR STEERS. Compudose extends the payout period two to three times longer than that of any other single implant.

Never again will you have to work your cattle just to implant. Never again need you suffer the labour expense, doubled implant costs, inconvenience and the loss of gains resulting from having to re-work your cattle.

The red line on this graph illustrates long term Compudose payout. Note that the Compudose payout is 2 to 3 times longer than any other implant. The yellow area represents the common reimplant period for conventional implants.

COMPUDOSE ... AN IMPLANT THAT CANNOT BE CRUSHED. The new concept Compudose implant is extremely durable, and in use, is virtually impossible to crush.

This means that there is little likelihood of erratic, surge payout and the resulting loss of implant performance.

WITH COMPUDOSE ... THERE IS NO WITHDRAWAL. This Compudose feature ensures marketing flexibility ... the option is yours to ship when the market is right. What's more, you have the advantage of sustained growth right up to the day of slaughter.

Canadian licensing trials were carried out over a period of three years, starting in Brooks Alberta, in October 1980. Other trials were conducted at Edmonton and Ridgetown, Ontario. This is the summary of these 3 Canadian finishing trials.

Looking at animal performance, the Compudose steers, on feed for an average of 168 days, outgained the non implant steers by 26.9 kg ... this translates to 59 pounds. The "bottom line" needs no translation.

Here we are looking at average daily gain and feed efficiency in the 3 Canadian finishing trials. On the left, increased average daily gain was 12.7% over the non implant steers. The column on the right illustrates an improvement in feed efficiency of 6.4% over the non implant steers.

The Canadian trials, the Compudose implanted steers produced a net return over the non-implant steers (on a $1.76/kg market ... 80 ¢/lb) of $32.87 per head.

Compudose vs single and reimplant programs for finishing cattle; this is a U.S. 5 trial summary.

This illustration compares Compudose to other single implant programs for average daily gain improvement. This summary from 5 U.S. feedlot finishing trials, showed a Compudose gain advantage throughout. Average daily gain was tabulated at various intervals as illustrated by this bar chart, from 84 through 164 days. These trials proved that the Compudose cattle had a gain advantage of 13.4 lbs per head as early as 84 days. That's right ... 84 days! When measured at two week intervals, Compudose continued to maintain this early gain advantage, compared to other single implants, through to the end of the trial period at 164 days.

Let's tie some dollars and cents to this comparative data. By 84 days, Compudose has an additional net return of $9.16 per head over other single implants. Essentially, the longer the trial period, the larger the difference. By the end of these trials at 164 days, the Compudose cattle have a $19.31 advantage over single implant programs.

Research data confirms what you already know, cattle drop off in performance when reimplanted. This is probably attributable to the stress and shrinkage resulting from the re-working activity. Data from 5 U.S. trials comparing Compudose with reimplanting programs, showed that steer performance is adversely affected up to 28 days ... almost a full month. This is illustrated when cattle are reimplanted at day 70 ... and note that it took up to day 98 before the reimplant cattle caught up to the

Compudose cattle. In this case, the Compudose advantage is measured in the losses avoided by not having to reimplant.

Reimplanting is a more costly practice than is sometimes realized. There is, of course, the out-of-pocket cost of 2 implants ... here costed at $1.30 each. Market research has determined reimplanting cost to range from $1.00 to $5.00 per head, for an average of $1.87 per head. This adds up to $4.47 per head, and may be more? What are your cost estimates? The evidence is pretty strong that with Compudose ... once is enough!

Unless you're a "rodeo star" by nature and love the "steer ressl'in" that reimplanting involves, consider Compudose ... the once is enough implant.

- 1 carton contains 10 boxes.
- Each box contains 100 implants, packed in 10 cartridges of 10 implants each.
- Each carton holds 1,000 implants.

The durable Compudose Implanter is light, easy to get the feel of and easy to keep clean and sanitary. The 10 implant cartridge locks securely into place.

COMPUDOSE ... DIRECTIONS FOR IMPLANTING. Confine the steer in squeeze chute. The ear should be clean and dry ... if contaminated with manure- clean with an antiseptic solution and dry prior to implanting. To load the Compudose Implanter ... pull plunger all the way back. Remove the protective cap from the cartridge and insert into the implanter.

Push plunger forward until implant lies in the barrel of the needle, at the first "click", in preparation for implanting. To load additional implants, pull plunger back and then advance knob on cartridge to the next position.

Use a clean needle with a sharp tip and disinfect the needle before each implantation. Deposit the implant under the skin on the back side of the middle third of the ear. Place implant between the skin and cartilage. Avoid major blood vessels. Grasp the tip of the ear with one hand and with the other holding the implanter penetrate the skin in the outer third of the ear. Do not penetrate the cartilage. Upon penetration, fully insert the needle between skin and cartilage ... for proper placement of the implant. Pull the needle back as the implant is being deposited, by pushing the plunger forward. After needle withdrawal ensure, with thumb and forefinger, the proper placement of the implant. Thoroughly clean the implant gun from time to time, and always prior to storage.

To summarize the Compudose implanting procedure: always fully insert the needle. Deposit the implant in the middle third of the ear where the skin is tight. Do not deposit the implant where the skin is loose, that is in the third of the ear nearest the head.

COMPUDOSE LABEL

Each implant contains 24 mg estradiol-17B impregnated in silicone rubber. For subcutaneous ear implantation in steers only. For improved feed efficiency and increased rate-of-gain in feedlot steers greater than 272 kg (600 lbs) body weight. Each COMPUDOSE controlled-release implant will provide an effective daily dose of estradiol for at least 200 days.

COMPUDOSE OFFERS YOU THESE BENEFITS

1. New delivery system, controlled estradiol release.
2. Longer payout
   - No need to reimplant.
   - Lasts longer than any other single implant.
3. Increased average daily gain.
4. Improved feed efficiency.
5. Compudose cannot be crushed, this means consistent performance.
6. No withdrawal.
7. Estradiol-17B ... a naturally occurring hormone.

PRO-BANMINTH

A CONTINIOUS DEWORMER FOR SWINE

Rob Burla, Western Regional Manager
Pfizer Animal Products

Each year worms in hogs cause farmers $6 - $7 million in losses. Worms cause unthriftiness in pigs, stunted growth, and poor feed utilization. That is why deworming of hogs should be a number one management practice concerning hog producers.

There are basically 3 types of worms that cause untold losses in your hogs - the large roundworm, the red stomach worm and the nodular worm. The large roundworm causes about 90% of all worm problems and losses. Because this worm causes such a large portion of losses it is important to know its life cycle.

PROBLEM OF LARGE ROUNDWORMS

Description:

Adult ascarids are off-white in color, about the size of a lead pencil in diameter and 6 to 14 inches long. Adult ascarids normally live in the small intestine. Under some conditions they may wander into stomach, gall bladder and bile ducts of the liver. The larvae migrate by way of the bloodstream through the liver and lungs and, occasionally, into various other organs and tissues.

Life Cycle:

The life cycle of the large roundworm is direct. In the small intestine, the female worm can lay millions of eggs daily, which are passed in the feces and must undergo development outside of the pig before they become infective.

The first-stage larva does not hatch from the egg under ordinary conditions but must undergo one molt to the second stage, which remains in the egg and is infective when ingested.

The larva will develop in the egg in almost any suitable environment. The first-stage larva develops in the egg within 10 days under optimum conditions of moisture and temperature. The infective, second-stage larva develops after another 13 to 18 days of incubation.

The pig becomes infected by swallowing eggs containing second-stage ascarid larvae in contaminated soil, feed and water. Nursing pigs may also become infected by swallowing infective-stage ascarid eggs on the udder. The infective larvae hatch from the eggs in the small intestine of the pig and enter the blood vessels in the intestinal wall by penetrating the intestinal lining.

The larvae are carried by the hepatic portal vein to the liver and may appear in the liver as early as 24 hours after infection. Larvae may also be found in various other organs. Maximum numbers of larvae have been recovered in the liver of pigs from 24 to 48 hours after a single infection.

Between 2 and 4 days after infection, most of the second-stage larvae molt to the third stage. By the 4th day, they have grown to a length of 500 to 600 microns. At the time of the molt to the third stage, most of the larvae are still in the liver.

From the 4th to the 6th day after infection, a number of larvae begin migrating to the lungs through the posterior vena cava and right side of the heart. The larvae migrate into the lung capillaries (blood vessels), penetrate the capillary walls into the alveoli (air sac) and ascend the bronchi to the pharynx (throat) where they are swallowed and returned to the small intestine. Studies show that most ascarid larvae reach the lungs 7 to 9 days after infection.

Migration from the lungs to the small intestine begins about 9 to 10 days after infection, and a large proportion of the larvae appear in the small intestine by the 11th day. The larvae molt again to the 4th stage soon after reaching the intestine. The final molt to the young adult stage occurs in the small intestine 21 to 29 days after infection.

Adult female roundworms lay eggs, which are deposited in the intestine and shed in the feces, and the life cycle continues. The large roundworm takes about 6 to 9 weeks to develop from the infective, second-stage larvae to the mature adult.

Harmful Effects of Roundworms:

Large roundworm infections can retard growth and cause general unthriftiness and digestive disturbances in pigs. Severely affected young pigs may die. Also, infected pigs can become more susceptible to other diseases.

Ascarid-infected pigs may show fever, labored breathing and a soft, moist cough, which becomes more pronounced after exertion. Also, weight gains and feed consumption may be reduced, leading to stunted growth and poor efficiency.

The harmful effects of ascarids are produced by the migrating larvae in the liver and lungs and by the adult worms in the intestines. The severity of symptoms during the migratory phase depends on the number of migrating larvae, presence of disease and diet of the pig.

Severe damage may occur in the liver and lungs, from which some pigs never fully recover. Permanent injuries in these organs are observed as scar tissue. The initial injuries in the peripheral areas of the liver result in the death of tissue (necrosis). These lesions heal by fibrosis (production of scar tissue), and repeated infection with many larvae leads to a generalized fibrosis. If the liver is not extensively scarred, the fibrosis may appear as "milk spots", but when the damage is extensive, broad bands of scar tissue are formed.

In addition, experimental evidence shows that ascarid infections combined with swine influenza organisms result in more extensive lesions and a significant increase in morbidity and mortality. In addition, controlled studies show that the lesions of enzootic (mycoplasma) pneumonia are greatly intensified by ascarid infections and are typical of the more severe field outbreaks.

The damage produced by adult large roundworms in the intestine includes digestive disturbances. Stunted growth and poor feed efficiency have also been associated with mature ascarid infections. In addition, adult ascarids tend to wander and may enter the gall bladder and stomach. They may stop the flow of bile by lodging in the bile duct. Assording to a survey, the bile ducts of many pigs condemned at slaughter for jaundice were found to be blocked by large roundworms. Also, heavy infections of adult ascarids may block the small intestine. They may even perforate the intestine. They may even perforate the intestine, producing a fatal peritonitis (inflammation of the membrane lining the abdominal walls and digestive organs).

PRO-BANMINTH

BACKGROUND AND DEVELOPMENT

Pyrantel tartrate is chemically related to Banminth 11 (morantel tartrate) currently sold by Pfizer in Canada. Both products belong to a family of organic compounds classified as tetrahydropyrimidines. Pyrantel tartrate possesses broad-spectrum anthelmintic activity against gastro-intestinal nematodes in many animal species and has unique preventative properties against the ascarid of swine.

Pyrantel tartrate's dosage forms have been widely used in livestock in the United States and other parts of the world since the early seventies. In Canada, it will now be available for use in swine.

PRO-BANMINTH

CHEMISTRY

Trademark:	PRO-Banminth
Generic Name:	Pyrantel tartrate
Chemical Name:	Trans-1-methyl-1, 4, 5, 6, -tetrahydro-2- (2-(thienyl)vinyl) pyrimidine tartrate
Chemical Form:	Salt of tetrahydropyrimidine base and L(+) tartaric acid
Molecular Formula:	$C_{15}H_{20}N_2O_6S(C_{11}H_{14}N_2S.C_4H_6O_6)$
Molecular Weight:	356.41

Tetrahydropyrimidine base:

Appearance:	Colourless crystalline solid
Solubility:	Approximately 16 gm/100 gm water at 24°C
Melting Point:	145.5-146.5°C

Mode of Action:

The method by which pyrantel tartrate produces its effect on gastro-intestinal parasites is by interfering with the neuromuscular function of the parasite. As a result, there is a marked contracture of the worm, followed by paralysis, then death and the parasites are expelled from the host animal.

Stability:

PRO-Banminth showed excellent stability in both pelleted and meal swine feeds as well as in its premix form.

In the premix form, PRO-Banminth retained 110.6% of its labelled potency after 18 months storage at room temperature. When combined with Mecadox in the same feed, potency retention after 12 weeks at 37°C was 107.3% of initial assay for meal feeds and 100.4% for pelleted feeds.

PRODUCT INFORMATION

Commercial Product:

PRO-Banminth Premix is available as a free flowing non-dusty premix, tan to brownish-tan in colour packed in a 25 kg fibre drum appropriately labelled. Each kilogram of premix contains pyrantel tartrate at a level of 106g/kg.

Indications for Use:

PRO-Banminth is to be mixed with Mecadox in the same feed for worm control and dysentery control.

When used in combination with Mecadox in the same feed, the indications for use are as follows:

1. For the prevention of migration and establishment of large roundworm (Ascaris suum) infections in swine.

2. As an aid in the prevention and control of swine dysentery (vibrionic dysentery, bloody scours or hemorrhagic dysentery).

Mixing Directions:

Mix 1 kg of PRO-Banminth Premix and 2.5 kg of Mecadox Premix-10 with 996.5 kg of feed to obtain a medicated feed with a concentration of 0.0106% (106 mg/kg) pyrantel tartrate and 0.0055% (55 mg/kg) of carbadox. This medicated feed can be prepared in the form of meal or pellets.

Feeding Directions:

The medicated feed is to be fed continuously as the sole ration for 5 - 7 weeks.

Warning:

Treated animals must not be slaughtered for use in food for at least 35 days after the latest treatment with this combination of drugs.

Caution:

1. Feed only to swine intended for slaughter.

2. Do not mix this drug combination in feeds containing pellet-binding agents with the exception of Lignosol (Premix and Supplement labels only).

SUMMARY OF PRO-BANMINTH AND PRO-BANMINTH/MECADOX EXPERIMENTS

Several experiments have been conducted both in Canada and the United States to demonstrate:

(a) The harmful effects of roundworm infection on pig performance.

(b) The effect of lung damage caused by the migrating ascarid larvae in the development of pneumonia.

(c) The efficacy of either PRO-Banminth alone or in combination with Mecadox in preventing the migration of and the establishment of roundworm infections in swine.

(d) The non-interference of pyrantel tartrate on the efficacy of Mecadox for the prevention of swine dysentery.

The following tables report, but on a few of these experiments.

Table #1 clearly shows that pigs not infected with roundworms versus infected animals grew 26.7% faster and utilized feed 3.5% more effeciently. A significant difference you will agree, and one that could have great economic significance to any hog production unit.

The experiment in Table #2 in which roundworm infected pigs were challenged with virus pneumonia, and the results compared with pigs that either had a roundworm infection only, or non-infected pigs challenged with the virus only. The results in terms of mortality and poor performers are quite obvious. The data shows that 56% of pigs infected with roundworm and influenza virus died or did poorly.

A study conducted to determine what effects ammonia from pit gasses had on the performance of roundworm infected pigs also confirms the severe impact on performance that roundworm infection has - roundworm infected pigs exposed to pit gasses had a 61% decrease in average daily gains.

Table #4 confirms a reduction of 89.4% in liver lesions after 45 days of Pro-Banminth medication. It also shows that after 39 days on Pro-Banminth medication, larvae detected in the lung tissue was reduced by 95.4% - further proof of the blocking action of Pro-Banminth against the Ascarid larvae.

The two experiments in Table #5 demonstrate the type of results one can expect in the reduction of liver lesions caused by the migrating ascarid. In this experiment conducted at the University of Saskatchewan, liver lesions were dramatically reduced after 52 days on test. In this second experiment conducted at the University of Saskatchewan, liver lesions were once again dramatically reduced. This proves that Pro-Banminth is highly effective in blocking the migration of the ascarid larvae picked up during re-infection.

In Table #6 this trial involving over 500 pigs, after 40 days on Pro-Banminth the prevention of roundworms was approximately 100%.

In Table #7 egg production was reduced by 90.5% on day 56 when compared to non-medicated controls - a full 28 days after the drug had been withdrawn. In other words, these pigs were protected for a full 8 weeks. Clear proof that larvae were prevented from migrating, thus developing into egg laying adults.

The Benefits Of Pro-Banminth Are:

Pro-Banminth will:-

(1) Block the migration of the immature roundworm.

(2) Prevent the establishment of the adult roundworm.

(3) Reduce the degree of shedding of roundworm eggs into the environment.

(4) Reduce the damage caused to the liver by the migrating stages of the roundworm.

(5) Reduces lung damage caused by the migrating stages of the roundworm.

(6) Reduces the incidence and severity of pneumonia and respiratory conditions in worm infected pigs.

Pro-Banminth in the feed for 5-7 weeks prevent the migration and the establishment of the roundworm in pigs. No other wormer sold in Canada can achieve this.

When fed in combination with Mecadox, the only in-feed medication with which it is approved, the Pro-Banminth/Mecadox in the same feed combination will in addition to preventing roundworm migration, prevent and control outbreaks of swine dysentery.

Table #8 shows that following a Pro-Banminth/Mecadox program in the absence of roundworm and swine dysentery infections, pigs will grow 8.4% quicker on 2.9% less feed.

In Table #9 when pigs on the combination medication program were challenged with swine dysentery they were over 9 kg heavier than control animals after 21 days on test and consumed 17 times less feed per kilogram of gain.

In Table #10 this study conducted at the University of Guelph demonstrates that Mecadox in combination with Pro-Banminth protects pigs against the ravages of swine dysentery. The medicated pigs performed as well as the non-infected, non-medicated group while the infected group had a 100% mortality rate.

Table #11, when medicated pigs were challenged with roundworm infection, they gained weight 36.5% quicker on 1.8% less feed than control animals.

In Table #12, this trial shows that when medicated pigs were challenged with both roundworm infection and mycoplasma pneumonia, they gained weight 42.8% faster on 20% less feed than non-medicated animals.

Summary:

Pro-Banminth and Mecadox used concurrently in the same feed over a 5-7 week period, is highly effective in preventing the migration and the establishment of large roundworms in the pig, while at the same time preventing outbreaks of swine dysentery.

The direct benefits to the Canadian Swine Industry by following this medication program are as follows:

(a) Prevention of Ascarid larval migration reduces the severity of pneumonia.

(b) Prevents outbreaks of swine dysentery in swine.

(c) Improves overall pig performance in the presence of these two common swine maladies.

(d) Reduces the level of ascarid egg shedding into the environment.

(e) Worm control is assured without additional work or expense in treating this condition separately.

(f) Fits readily into any feeding program for young growing pigs.

TABLE #1

Roundworm Infection Affects Pig Performance

	Roundworm Infected Pigs	Non-Infected Pigs
Number of Pigs	6	6
Avg. Initial Wt. (kg)	8.85	8.97
Avg. Final Wt. (kg)	31.58	37.58
Avg. Daily Gain (kg)	0.435	0.551
% Improvement in A.D.G.	—	+26.7%
Feed Efficiency (kg/kg)	2.30	2.22
% Improvement in F.E.	—	+3.5%

Exp. 1220-02-79-005 (University of Saskatchewan)

— Non-Infected Pigs were 6 kg heavier
— Non-Infected Pigs grew 26.7% faster
— Non-Infected Pigs utilized feed 3.5% better

TABLE #2

Effect of Swine Influenza Virus and Roundworm Infection in Pigs

Infections	Number Pigs	Dead	Poor	% Dead or Poor	Fair	Good	% Fair or Good
1. Infected — Roundworms only	5	0	0	0%	0	5	100%
2. Infected — Virus only	26	0	1	4%	3	22	96%
3. Virus — Roundworm Infection	16	7	2	56%	5	2	44%

Underdahl: J.A.V.M.A. — Oct. 1958 — p. 381

TABLE #3

"Compared with controls, percentage reductions in average daily gains for pigs exposed to atmospheric ammonia were:"

Ammonia Exposed only	— 32% in A.D.G.
Ascarid Infected only	— 28% in A.D.G.
Ascarid Infected plus Ammonia Exposure	— 61% in A.D.G.

Drummond et al: Am. J. Vet Res: Vol. 42, No. 6, p. 969 — June 1981.

TABLE #4

Efficacy of PRO-Banminth* Against the Large Roundworm Migration

Reduces Lung Damage

	Non-Medicated Controls	PRO-Banminth*
Larvae/Gram of lung:		
No. of experiments	2	2
No. of pigs on test	47	47
No. of pigs necropsied	15	15
Avg. days on PRO-Banminth*	—	39
Avg. No. of Ascarid Larvae per gm of lung	109	5
% Efficacy	—	95.4%

Reduces Liver Lesions

	Non-Medicated Controls	PRO-Banminth*
Liver Lesions		
1) Total liver lesions		
No. of experiments	4	4
No. of pigs on test	143	145
No. of pigs necropsied	47	48
Avg. days on PRO-Banminth*	—	45
Avg. No. of Ascarid Lesions in liver	311	33
% Efficacy	—	89.4%

- Reduces lung damage by 95.4%.
- Reduces liver lesions by 89.4%

Technical Information Bulletin #122 PFIZER U.S.

TABLE #5 **PRO-Banminth* Reduces Liver Damage**

Treatment	Pigs on Test	Days on Test	Average Liver Lesion Density*
Infected, non-medicated	5	52	Too numerous to count
Infected, medicated PRO-Banminth*	6	52	1.33

Expt. 02-79-005 — University of Saskatchewan

*Average No. of milk spots per liver lobe

Treatment	Pigs on Test	Days on Test	Average Liver Lesion Density*
Infected, non-medicated	4	35	Too numerous to count
Infected, medicated PRO-Banminth*	4	35	6.0

Expt. 02-77-010 — University of Saskatchewan

*Average No. of milk spots in representative area 6 cm^2

TABLE #6 **Prevents Establishment of the Large Roundworm**

	Non-Medicated Controls	PRO-Banminth*
Worm Count at Necropsy*		
No. of experiments	9	9
No. of pigs on test	258	260
No. of pigs necropsied	123	125
Avg. Days on PRO-Banminth*	—	40
Avg. Worm Count at Necropsy*	38	1
% Efficacy	—	Approx. 100%
Fecal Egg Count (EPG)*		
At drug withdrawal:		
No. of experiments	14	14
No. of pigs on test	406	414
No. of pigs sampled	361	361
Avg. days on PRO-Banminth*	—	37
Avg. Fecal egg count	997	12
% Efficacy	—	98.8%

Technical Information Bulletin #122 PFIZER U.S.

TABLE #7

Reduces Egg Counts

	Non-Medicated Controls	Medicated PRO-Banminth*/ Mecadox*
Number of Pigs	15	15
Days on Medication	—	28
Eggs/g Feces:		
At day 0	1.0	2.2
At day 28	1.0	3.2
At day 56	37.9	3.6
% Reduction:		
At day 0	—	0
At day 28	—	0
At day 56	—	90.5%

Zimmerman et al: Journal of Animal Science Vol. 55, No. 4, 1982, p. 736

TABLE #8

Effect of PRO-Banminth*/Mecadox* on Pig Performance

In the absence of disease (Roundworm and Swine Dysentery Infections)

	Non-Medicated Controls	Medicated PRO-Banminth*/ Mecadox*
Number of Pigs	24	24
Days on Test	49	49
Avg. Daily Gain (kg)	0.574[a]	0.622[b]
Improvement Due to Medication	—	+8.4%
Feed Efficiency (kg/kg)	2.606	2.534
Improvement Due to Medication	—	+2.9%

Expt: 1220-02-79-019, Bonville, Ontario

a, b — Values with different superscript are significantly different ($P \leq .05$)

TABLE #9

Effect of PRO-Banminth*/Mecadox* on Pig Performance in the Presence of Swine Dysentery

	Infected Non-Medicated	Infected Medicated PRO-Banminth*/ Mecadox*
Number of Pigs (initial)	10	10
Days on Test	21	21
Avg. Initial Wt. (kg)	15.2	15.2
Avg. Final Wt. (kg)	15.6	25.05
Total Gain (kg)	0.4	9.85
A.D.G. (kg)	0.019	0.469
Improvement in A.D.G.	—	+2468%
Feed Efficiency (kg/kg)	34.21	2.32
Improvement in F.E.	—	1475%

Expt: 1120A-71-012 Pfizer Inc., Terre Haute, Indiana

TABLE #10

Effect of PRO-Banminth*/Mecadox* on Pig Performance in the Presence of Swine Dysentery Challenge

	Non-Infected Non-Medicated	Infected Non-Medicated	Infected Medicated PRO-Banminth*/ Mecadox*
Number of Pigs	6	6	6
Days on Test	35	35	35
Avg. Initial Wt. (kg)	7.0	7.0	7.0
Avg. D.G. (kg)	0.4	−0.04	0.46
Mortality %	0	100	0
Feed Efficiency (kg/kg)	2.74	—	2.17

Expt: 1120-02-79-003 University of Guelph

TABLE #11

Effect of PRO-Banminth*/Mecadox* on Pig Performance in the Presence of Roundworm Challenge

	Infected Non-Medicated	Infected Medicated PRO-Banminth*/ Mecadox*
Number of Pigs (initial)	6*	6
Days on Test	52	52
Avg. Initial Wt. (kg)	8.85	8.85
Avg. Final Wt. (kg)	31.58	39.70
Improvement in Gain (kg)	—	+8.12
Avg. Daily Gain (kg)	0.435[a]	0.594[b]
% Improvement due to medication	—	+36.5%
Feed Efficiency (kg/kg)	2.30	2.26
% Improvement due to medication	—	1.8%

Expt: 1220-02-79-005 — University of Saskatchewan

[a, b] values with different superscript are significantly different ($P \leq .05$)

*1 pig died on day 11 due to pneumonia caused by migrating roundworm larvae.

TABLE #12

Effect of PRO-Banminth*/Mecadox* on Pig Performance in the Presence of Roundworm Infection and Mycoplasma Hyopneumonia Challenge

	Infected Non-Medicated	Infected Medicated PRO-Banminth*/ Mecadox*
Number of Pigs	15	15
Days on Test	28	28
Avg. Initial Wt. (kg)	16	16
Avg. Final Wt. (kg)	25.8	30.0
Gain Increase (kg)	—	+4.2
Avg. Daily Gain (kg)	0.35	0.50
% Improvement due to medication	—	+42.8%
Feed Efficiency (kg/kg)	3.12	2.50
% Improvement due to medication	—	+20.0%

Zimmerman et al: Journal of Animal Science: Vol. 55, No. 4, 1982, p. 736

EDITORIAL BACKGROUNDER

CHEM-CAST™

by Ron Strutt
Boehringer Ingelheim Ltd.

An Efficient and Safe Method of Castration for the bovine By the Intra-Testicular Injection of Chem-Cast™

For centuries, the practice of castration, effecting elimination of the testes and reducing libido and virility, has been carried out in various ways. The methods have varied with species, the opportunity to observe the animal following castration, and the nature of local disease problems. Such diseases as tetanus, black leg, malignant edema and the presence of the screw worm fly may cause severe problems following castration by methods which result in an open wound or abrasion.

With these concerns in mind, the cattle industry has tried to find a method of castration as effective as surgical castration, but free of the disadvantages of post-surgical inflammation and the risk of hemorrhage and infection. These latter two problems may result in 5 to 15% death loss depending on weather conditions, management practice and surgical technique.

To avoid some of these problems, castration procedures have been performed using rubber bands above the testis to effect destruction of the testis, below the testes to push the testes against the body wall effecting hyperthermia of the testis and reduction of testical development and/or sperm maturation, knotting of the vascular supply and vas deferens by rotating of the testis within the scrotum, and many other even lesser acceptable methods.

Until the advent of Chem-Cast, the one popular method that best meets the criteria of avoiding infection and hemorrhage, particularly in cattle, has been the method whereby the spermatic cord and its attendant blood vessels are mechanically crushed with an instrument commonly known as a Burdizzo.

This method of castration, generally called "clamping", usually renders the animal sterile by destroying the blood supply to the testis proper and effects varying degrees of testicular regression and resorption of the residual testis. This method also has its inherent drawbacks.

The problems most commonly observed with the use of the Burdizzo are 1) complete scrotal and testis necrosis with and without secondary hemorrhage effected by completely transecting the scrotal sack when "clamping" the testis/or testes; 2) edema that in some cases can be marked and persist for some time especially in older bulls; 3) "missed castration" whereby the spermatic cord slips out of the jaws of the Burdizzo or never was properly placed during "clamping"; 4) post-"clamping" distress which is exhibited by standing hunched up, lying down, reluctance to move and reduced appetites. Such stress may persist for several hours to several days depending on the age of the calf and the degree of post-"clamping" swelling that occurs; 5) difficulties with the use of the standard (18 inch or more) Burdizzo on small calves, 3 to 4 months of age or less; 6) secondary infections of the necrosed scrotum and testis or traumatized skin of the scrotum and/or hematomas of the genitalia following crushing and "breaking".

Therefore, it is evident that a method of castration that is easily accomplished, effective, and safe is needed. Chem-Cast, a chemical solution designed for intra-testicular injection, and restricted to sale by the veterinarian, is such a product and offers distinct advantages over the other methods of castration. Chem-Cast is simple and fast to administer. In trials, Chem-Cast approached the effectiveness of surgical castration and was more effective than the Burdizzo method. The administration of Chem-Cast does not result in the pain, edema, hemorrhage and unacceptable necrosis as inherent in the surgical and Burdizzo methods of castration; and further, it reduces the high risk of infection associated with the surgical procedure.

Chem-Cast field use data was generated in 23 separate trials carried out in five different regions using 1,426 beef, dairy, dairy-beef and cross breed beef cattle. That data substantiates Chem-Cast's superior effectiveness over Burdizzo clamping as a method of castrating calves.

In these 23 trials, the 1,426 calves were randomly treated by one of six veterinarian investigator-consultants or the veterinarian study director or assistant study director. The method of Burdizzo castration, as well as the instrument used, was as routinely practiced by the individual doing the castration.

Chem-Cast and Burdizzo success rates achieved for castration (complete elimination of both testes) and functional castration (remaining residual testicular tissue in one or both sides less than 2.5 cm round) are presented in Table 1.

Chem-Cast treatment results with regard to calves successfully castrated and functionally castrated clearly favors Chem-Cast over Burdizzo.

Based on this and other supporting data, Boehringer Ingelheim applied to the Bureau of Veterinary Drugs to register and licence a prescription product labeled for sale to licensed veterinarians only. It carries the following intra-testicular injection label dose to weight recommendations for use in normal bull calves:

100 lbs. - 1.0 ml per testis
101-150 lbs. - 1.5 ml per testis

It has been demonstrated that all Chem-Cast-injected calves were sterile and that serum testosterone levels for steers castrated with Chem-Cast are no different than the serum testosterone levels for Burdizzo castrated steers.

Estrogen and progesterone data generated to support the human safety portion demonstrated there are no differences between hormone levels in Chem-Cast and Burdizzo castrated steers. Chem-Cast has also been declared as a GRAS (Generally Recognized as Safe) item by the Bureau of Veterinary Drugs, and requires zero days tissue withdrawal before slaughtering cattle treated with Chem-Cast. A very wide margin of safety exists when using Chem-Cast as labeled.

It also has been demonstrated that Chem-Cast castration reduces animal setback as evidenced by no interference of feed consumption or daily gain. Trials indicate Chem-Cast can reduce medical treatment days as compared to surgically and Burdizzo castrated calves for the four-week period following castration.

This "no setback" data was generated by dividing 45 five-week-old calves into two groups that were then randomly subdivided into Surgical, Burdizzo and Chem-Cast treatment groups. All groups were treated on the same day, similarly housed and all nutrient consumption and medical treatments were regularly evaluated and recorded. Results are presented in Tables II and III.

TABLE I: CLINICAL EFFICACY RESULTS FOR CALVES TREATED WITH CHEM-CAST™ AND BURDIZZO TREATED CONTROLS

Weight Range-Pounds	Treatment Chem-Cast™ or Burdizzo	Successfully[a] Castrated	Clinical Successes[b]	Total Non-Fertile Successes
100	1.00 ml	(98%)	(100%)	(100%)
	Burdizzo	(73%)	(80%)	(80%)
101-150	1.50 ml	(95%)	(98%)	(100%)
	Burdizzo	(71%)	(86%)	(93%)

a = Clinically Castrated - Calves with no remaining testicular tissue
b = Calves with minimal (2.5 cm round) residual testicular tissue remaining

TABLE II: AVERAGE DAILY GAIN AND FEED EFFICIENCY IN CASTRATED CALVES TO 28 DAYS AFTER CASTRATION

Trial No.: 37-807-80-6

0-28 DAYS	A.D. GAIN	LB. GAIN PER LB. GRAIN	
GROUPS		GAIN	GRAIN
Chem-Cast	2.1	1 :	1.20
Surgical	1.85	1 :	1.36
Burdizzo	1.86	1 :	1.33

TABLE III: TREATMENT OF CALVES FOR CALFHOOD DISEASES FOR FIVE (5) WEEKS FOLLOWING CASTRATION

Combined Groups
Lesser/Better Quality Calves

Trial No.: 37-807-80-6

Castration Groups	Total No. Calves	Calves Treated Total No. Treated	 Total No. Treatments
Chem-Cast	16	0	0
Surgical	14	7	19
Burdizzo	15	9	26

Embryo Transfer and Genetic Engineering

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APPLICATION

Genetic Improvement

Genetic progress is considered to be slower through the use of embryo transfer than it is using conventional artificial insemination (A.I.), especially on a national herd basis [1]. However, with increased selection intensity and shortened generation intervals, ie. transferring female offspring, genetic gain can be made on a within-herd basis [2]. In monotocous animals like the cow, the production of about six offspring per donor could double selection intensity and the rate of response to genetic selection for traits such as growth that can be measured in both sexes [3,4,5]. This would be especially worthwhile in improving elite herds, the genetics of which could be spread over a large population through the use of A.I. Although the rate of genetic improvement in dairy cattle may range from 2.5 - 8%, Seidel suggested that through the use of embryo transfer it could be increased three to four times if dairy replacements were selected from the top 10% of the herd [6]. Embryo transfer is now commonly used to produce A.I. sires from the very best proven cows and bulls available. Economics would not at this time support the use of embryo transfer techniques for anything but seedstock production.

Planned Matings

By far the most common use of embryo transfer in animal production programs is the proliferation of so-called desireable genotypes [7]. A.I. has permitted the widespread dissemination of a male's genetic potential. Embryo transfer provides the opportunity of disseminating the genetics of proven elite females [8]. Embryo transfer also permits the development of herds of genetically valuable females, most of which may be sibs if not full-sibs. As A.I. has led to the very valuable bull, now embryo transfer has resulted in the very valuable female. Many breeders have identified individual females whose offspring are most saleable and used them exclusively in embryo transfer.

Embryo transfer has also been used to rapidly expand a limited gene pool. The dramatic rise of the embryo transfer industry in North America is a direct result of the introduction of European breeds of cattle, which were then in short supply. Similarly, embryo transfer can be used to increase the population base of rare or endangered breeds or species, providing recipients of a more plentiful breed or species that will accept the embryo are available [9]. Recipient selection is an important limitation to the use of embryo transfer in endangered species of animals.

Genetic Testing for Mendelian Recessive Traits

A common use of embryo transfer procedures is to genetically test A.I. sires for deleterious heredity traits [10]. Some A.I. organizations keep known carriers of certain genetic defects on hand to serve as donors in testing new sires. Embryos are transferred into unrelated recipients and pregnancy may be terminated at various stages to examine fetuses for presence or absence of the defect. Depending on the heritability of the defect, generally eight to ten non-affected fetuses are sufficient to declare a bull free of that trait. Another alternative is to mate the bull in question to seven or eight of his superovulated daughters. Offspring will then represent all recessive traits that a bull may carry. A less attractive alternative would be to naturally mate the bull in question to 40-50 of his daughters.

Twinning in Cattle

Compared to other domestic animals, beef production is somewhat less efficient because not all cows produce a calf each year. However, it has been estimated that unit beef production can be increased by 60% in intensively managed herds through twinning. Approximately 70% of nutrient intake by a beef cow is utilized for her own maintenance, whereas only about 30% is for growth and maintenance of the calf during pregnancy and lactation [6]. Thus, it seems desireable to take advantage of the efficiency of gestation and lactation. Genetic selection for twinning in cattle has been largely unsuccessful [11] and gonadotrophin treatments to induce twinning have also been unreliable [12,13]. Embryo transfer does provide a very real alternative in the production of twins [14].

The most limiting factor at this time is the cost of transfer which continues to exceed the average price for newborn calves to be raised for meat [7]. The nonsurgical transfer of a previously frozen embryo to a recipient that has already been serviced may become a economical method of producing twins. Other alternatives include the nonsurgical transfer of two or three frozen embryos to commercial beef cows [15].

It must be remembered that recipients carrying twins will require extra nutrition and management, especially around calving. Furthermore, recipients must be sufficiently large to carry twins and produce enough milk to feed twins [16]. Freemartins, make twinning unattractive for purebreeding purposes. However, the incidence is relatively low and sexing of embryos would eliminate the problem entirely. Similarly, the production of identical twins by micro-surgery would make twinning very feasible for embryo transfer programs in purebred herds [17].

Disease Control

Infectious diseases in the bovine species seem unlikely to be transmitted by the embryo [18]. Consequently, it has been suggested that embryo transfer be used to salvage genetics in the face of a disease outbreak. This may be a useful alternative in the establishment of dairy herds that are free of Bovine Leukosis as this virus was not transmitted with embryos [20]. Similarly, embryo transfer has proven to be effective in the introduction of new bloodlines into Specific-Pathogen-Free pig herds [21]. However, much research has yet to be done on embryo-virus interactions, especially in swine before this technique can be done with complete confidence [18].

Import and Export

The intercontinental transport of a live animal may cost $1,000 or more, whereas an entire herd can be transported, in the form of frozen embryos, for less than the price of a single plane fare. This may be the single most important potential application of embryo transfer. Additional benefits of the export of embryos over that of live animals includes a wider genetic base from which to select, the retention of genetics within the exporting country and adaptation. This is particularly true of tropical and subtropical climates where the embryo would have the opportunity to adapt both in and then on a recipient indigenous to the area.

There are several potential problems which must be overcome in order to make the international movement of embryos common-place. Firstly, this use is dependent on the successful freezing of embryos. Secondly, the inadvertent introduction of disease into a herd and/or country with or within the embryo presents some very difficult regulatory problems. Well defined methods of collection, handling and washing embryos must also be followed to ensure that disease transmission is avoided [18]. Finally, the international movement of embryos is heavily dependent on technology transfer as personnel within the importing country must be able to successfully thaw and transfer embryos.

Salvage of Reproductive Function

Embryo transfer procedures have been useful in the diagnosis, treatment and salvage of reproductive function in so-called infertile cows [22,23,24,25]. Similar benefits have been demonstrated in the mare [26]. Although it is recommended that the cause of the infertility not be of genetic origin, this is often difficult to determine. The marketplace should sort this out if a genetic problem was inadvertently propagated through embryo transfer.

Another very important use of embryo transfer is to salvage the genetics of terminally ill animals. It may be possible to produce an additional two or three offspring through embryo transfer before the animal dies. The fact that the animal may not be cycling can be overcome through the use of progestational steroids given by injections or implant [27].

Research

Embryo transfer techniques have proven to be a very useful research tool. In fact, many technical developments in embryo transfer prior to 1970 were directed toward research purposes rather than for the propagation of superior livestock. These studies included natural limitations to twin pregnancies, uterine capacity, endocrine control of uterine environment, maternal recognition of pregnancy, embryo-endometrium interactions, and the endocrinology of pregnancy [28]. Studies that were originally planned to answer basic physiologic questions are now being used to improve and increase the utilization of embryo transfer. Newer techniques have added an entirely new perspective to the utilization of embryo transfer for research purposes. The production of identical twins, clones, chimeras, to mention a few, will certainly advance many of these sciences [29].

DONOR SELECTION

Every breeder will have his own reasons which are more often economic than genetic for wanting to do embryo transfer on a given animal. As optimal results will reduce costs, making the procedure much more economical, donor selection may involve a previous history of success in embryo transfer. In addition, it has been suggested that the potential donor animal be at its prime reproductive age, that it has a previous history of a high level of fertility and that it has demonstrated superiority in traits of economic importance[4,30]. Strict selection criteria will not only ensure genetic superiority, but should also ensure a high level of success thereby making the procedure more economical.

GENERAL PROCEDURAL STEPS

Selection of the donor and the decision whether or not she is to be superovulated will depend on the application and species. The donor may be inseminated naturally or artificially and embryos may be collected surgically or nonsurgically at an appropriate time after breeding, again depending on the species. Collected embryos must be identified, evaluated and maintained in a suitable medium prior to transfer. At this point they may also be subjected to manipulations, such as splitting, sexing and may be cooled or frozen for longer periods of storage.

As recipients must have been in estrus at the same time as the donor, it is essential to know their reproductive histories and to have sufficient recipients for the number of embryos to be transferred. The use of frozen embryos and synchronizing compounds makes the maintenance of a large recipient herd redundant.

EMBRYO TRANSFER IN THE COW

Embryo transfer technology has been most extensively applied in the bovine species. Not only is there an economic incentive, but the cow is well suited to complete utilization of nonsurgical techniques making the procedure more cost-effective. Finally, the cow is easy to work with making cattle excellent experimental animals.

Although it is possible to collect single embryos from the cow with good success and through the use of prostaglandin (PGF)2a to do so every 10 days, most cows are superovulated prior to embryo collection. The cow seems to superovulate best if gonadotrophin treatment is begun around day 10 of the cycle[31,32,33]. Forty-eight to 72 hr after initiation of treatment, the cow is treated with a luteolytic dose of PGF and she is normally in heat 36-48 hr later. Recipients are treated with PGF 12-18 hr before the donor cow so that estrus will be synchronous between donor and recipients. As multiple ovulations have been shown to take place over as long as 24 hr, multiple inseminations are usually done. Normally the donor cow is inseminated with a single vial of semen at 12, 24 and 36 hr after the onset of estrus.

Pregnant mares serum gonadotrophin (PMSG) as a single injection of 2000-3000 IU[34,35], or twice daily injections of a total dose of 28-50 mg

porcine pituitary follicle stimulating hormone (FSH-P, Burns Biotec, Omaha, U.S.A.) have been most commonly used to superovulate cows [30,36,37]. Most have found superovulatory results to be superior with FSH-P than with PMSG [38]. It seems that this may be associated with the shorter biological half-life of FSH-P.

Initially, embryos were collected surgically from the cow around day 4 after estrus [39]. However, three reports appeared in the same journal on the successful nonsurgical collection of bovine embryos in 1976 [40,41,42]. Basically, techniques described involved the passage of a cuffed rubber catheter through the cervix and into one of the uterine horns on days 6 to 8 after estrus. Embryos were then collected by a closed continuous or interrupted flow system [30], or by an interrupted syringe technique [36].

Embryos are located with a stereoscopic microscope after settling and syphoning or aspiration [36], or after filtering through a plankton filter [43]. Although embryos are usually transplanted as soon as possible after collection, it is possible to culture embryos for several hours at 35-37°C [44]. If transfers are to be done soon after collection, embryos may be maintained at room temperature. It is also possible to cool bovine embryos and to maintain them in the refrigerator for 2-3 days [45]. As a final alternative, embryos may be frozen for use at a later date.

Embryos are normally cultured in the same or a similar medium to that in which they were collected. Media must be buffered to maintain a pH of 7.2 - 7.6 and have an osmolarity around 300 mOs [46]. Traditionally, embryos were collected in Tissue Culture Medium 199 (TCM 199) enriched with bovine serum albumin or heat inactivated fetal calf serum (FCS) and antibiotics [44]. However, as TCM 199 requires CO_2 for its buffer system, it has largely given way to Dulbeccos phosphate buffered saline (PBS) enriched with FCS and antibiotics. Glucose and pyruvate are often added for longer terms of culture. Normally, enriched PBS with 1-2% FCS is used for flushing embryos from the uterus, whereas, embryos are cultured in the same medium with 15% FCS [44]. There is evidence that more complex media such as Ham's F-10, which has a carbonate buffer, yields superior results for long term culture of bovine embryos [44].

Embryos are classified and evaluated by morphological examination at 50-100X magnification [30,47,48]. The overall diameter of the bovine embryo is 150 to 190 um including a zona pellucida thickness of 12-15 um. The overall diameter of the embryo remains virtually unchanged from the one-cell stage until blastocyst expansion [48]. Generally, the embryo is described as to its stage of development and quality. The best predictor of an embryo's viability is its stage of development relative to what it should be on a given day after ovulation [47]. Embryos of good and excellent quality and at the developmental stages of late morula to blastocysts yield the best pregnancy rates. It is adviseable to select the stage of embryo for the synchrony of the recipient [30,36]. Other methods of embryo evaluation included <u>in vitro</u> culture and vital staining [49].

Transfers of embryos in the cow can be made with good success only if the preceding estrus in the donor and recipient occurred within 2 days of each other. Alternately, recipients must be synchronous with the stage of development of embryos that had been frozen previously. Recipients can be made available by maintaining a large herd to obtain natural heats or recipients may

be synchronized with PGF which is much more economical. Most recipients are chemically synchronized regardless of whether embryos transfers are to be done at an embryo transfer center or "on farm."

Until very recently, most embryo transfers in the cow were done surgically [50,36], whereas, presently most are done using nonsurgical methods [51,52]. Surgical transfers were done initially by way of a midline incision which necessitated a general anaesthetic and rather elaborate facilities. During the mid to late 1970's, surgical transfers were done by way of a flank incision which was quicker and did not necessitate the same sophistication in facilities. This made "on farm" embryo transfer possible and added a whole new perspective to the use of embryo transfer in cattle production schemes. More recently, the use of nonsurgical embryo transfers has increased the utilization of this technology in cattle breeding schemes because of even less elaborate requirements.

For surgical transfers, the uterine horn adjacent to the ovary bearing the corpus luteum (CL) is exteriorized and the embryo is deposited through the uterine wall into the uterine lumen with a Pasteur pipette or an intravenous catheter. Nonsurgical embryo transfer techniques utilized today involve the use of a Cassou A.I. pipette or some similar apparatus [51,53]. The embryo is placed in the uterine horn adjacent to the ovary bearing the CL by passing the pipette through the cervix, very similar to A.I. Practice and dexterity seem to improve one's ability to achieve high pregnancy rates suggesting that trauma to the endometrium may be a limiting factor in this method of embryo transfer. Stimulation of the cervix and inadvertent introduction of bacterial contaminants do not seem to be major determinants under normal circumstances [51,53]. With practice and attention to detail, pregnancy rates with nonsurgical transfers can approach that of surgical transfers [51,52].

With existing technology, an average for each donor cow superovulated would be eight to 10 ova collected, six to seven embryos transplanted and three to four pregnancies resulting. It must be emphasized that very few donor cows are average. Pregnancy rates are generally around 60% with fresh embryos and range from 30% - 40% with frozen embryos. One can anticipate a fetal death loss of 10% from pregnancy diagnosis until the calf is six months old [7].

EMBRYO TRANSFER IN SHEEP & GOATS

The low unit value of most sheep and goats restricts the widespread use of embryo transfer technology as it is presently practiced. However, specific applications include import/export, disease control, the increased utilization of out of season breeding and occasionally, the rapid multiplication of exceptional females with acceleration of genetic intervals [54].

The two most commonly used gonadotrophin preparations for superovulation in sheep and goats are 1000-2000 IU of PMSG by a single injection or FSH-P administered twice daily for a total dose of 18-24 mg [55,56]. Generally, FSH-P gave a higher ovulation rate with a lower incidence of unovulated follicles than PMSG [57]. Others have used crude equine pituitary extracts with success [77].

Normally, superovulation treatments are initiated around mid to late cycle, PGF is administered 24-72 hr later and estrus occurs 24-36 hr after PGF [54]. Estrus and ovulation may also be controlled with progesterone or synthetic

progestagens, eg. vaginal sponges for 12-14 days in sheep and 14-18 days in the goat [56]. It is also possible to combine progestagens and PGF treatment with the latter being administered at sponge removal. This permits a considerable shortening of progestagen treatment, but is limited to use during the breeding season.

Breeding can be done naturally or artifically at estrus. However, fertilization failure frequently occurs in the ewe, especially those showing a high superovulatory response. This can be overcome by surgical deposition of semen into the uterus [58].

Recipients can be drawn from a large flock showing natural cycles or they may be chemically synchronized. PGF can be used 12-24 hr before the donor as a single injection or as a double injection 8-10 days apart in sheep and 10-12 days apart in the goat [54]. Similarly, progesterone or intravaginal progestagens can be used along with 300-500 IU PMSG at sponge removal to synchronize recipients [59]. This approach will facilitate embryo transfer out of the normal breeding season.

Collection and transfer procedures for the ewe and doe have been described[60] and have changed very little over the years. Surgical techniques and general anaesthesia are required for both collection and transfer because of the tortuous nature of the cervix, although potential does exist for the utilization of nonsurgical techniques in the doe.

Surgical collections are normally done 3 to 4 days after estrus when the embryo is at the 8-16 cell stage of development. Embryo evaluation and culture techniques are similar to the bovine. Sheep embryos transferred to the rabbit oviduct[61] have also remained viable for several days.

Most transfers in small ruminants are performed surgically, although there are a few reports of successful nonsurgical transfer in the goat [62]. The reproductive tract is approached through a ventral midline incision and embryos of less than eight cells are transferred into the oviducts, whereas, embryos of more than eight cells[63,64] are transferred to the uterine horn adjacent to the ovary bearing the CL.

EMBRYO TRANSFER IN SWINE

The major reason for doing embryo transfer in swine is for the prevention and/or control of infectous disease [21]. Although swine producers invariably utilize superior females, this is seldom the primary reason for doing embryo transfer. Even the most valuable donors and embryos are inexpensive compared to costs incurred when some of the common diseases of swine are introduced into a susceptible herd. In 1981 about 43% of all transfers done in the U.S.A. were done to establish herds free of pseudorabies from donor herds under quarantine for this disease and 26% were done to introduce new breeding animals into Specific-Pathogen-Free herds[21].

As the CL of the sow is not susceptible to PGF prior to day 11 or 12 of the cycle, synchronization can be difficult. However, sows can be synchronized by weaning piglets and injecting 500-750 IU PMSG with the estrus occurring in 4-5 days. Alternatively, sows may be bred as they come into estrus and then aborted with PGF 16-45 days later[65]. Finally, sows can be made pseudopregnant

with daily injections of an estrogen preparation on day 11 through 15 of the estrous cycle. The CL of pseudopregnancy is susceptible to PGF with estrus being expressed 4-7 days later [66]. Sows are usually superovulated with one injection of 1200 IU of PMSG at the time that estrus is being synchronized. As pigs are multiple ovulators, superovulation is not normally practiced in gilts and sows in which embryos are to be collected on two or more consecutive estrous cycles.

For optimum conception and fertilization rates, donors should be mated every 12 hr throughout estrus. When 500 IU HCG is administered 3-4 days after PMSG, inseminations are done 24 and 36 hr after the HCG [65].

Swine embryos are usually collected surgically under general anaesthesia by mid-line incision 4 to 6 days after the onset of estrus. At that time embryos will range from 4-8 cells to expanded blastocysts. Collection after day 6 will yield hatched blastocysts which are unlikely to result in pregnancies. Morulae seem to give best pregnancy rates [65]. Transfer of swine embryos is also done surgically under general anaesthesia and by mid-line incision. Embryos are usually transferred to the anterior one-fourth of one uterine horn. Embryos then migrate from one horn to the other and become equally distributed throughout both horns. A minimum of four viable embryos are necessary to maintain pregnancy in the sow. [67].

LONG-TERM PRESERVATION OF EMBRYOS BY FREEZING

One of the earliest attempts to freeze mammalian embryos was reported in 1952[68]. However, few reports on embryo freezing appeared before the success of Whittingham in 1972[69]. This group used a wide range of cooling and thawing rates, in the presence of glycerol or dimethylsulphoxide (DMSO) as cryoprotective agents, and found that when mouse embryos were cooled at a rate faster than 2°C/min, survival was low. When the cooling rate approximated 0.3°C/min and warming rate approximated 10-15°C/min embryo survival was very high. This demonstration of an optimum cooling and thawing rate for mouse embryos was very important in the development of further technology.

Bank and Maurer applied similar techniques in the successful freezing and thawing of rabbit embryos [70]. Although two calves were born from frozen embryos, initial research with cattle yielded poor results [71]. In 1977 a successful program for the freezing of sheep embryos was applied to bovine embryos, resulting in the birth of numerous calves [72].

Successful embryo freezing has many applications in embryo transfer programs. Firstly, recipient management is improved and made more cost effective. In addition, season of parturition can be controlled, even though embryo collection and freezing may take place year around. Embryo freezing also allows progeny and performance tests of sibs to be conducted more rapidly and efficiently. Further, full sibs or identical sibs can be frozen until the genetic worth of those transferred can be established. Finally, embryo freezing is necessary for international movement of embryos because it eliminates critical timing and allows disease testing while the embryos are held in quarantine.

Basic Principles

The freezing of a living cell constitutes a complex physiochemical process of heat and water transport between the cell and its surrounding medium[73,74]. There exists an optimum cooling rate for each cell type[73]. It is dependent on the size of a cell, its surface to volume ratio, its permeability to water, and the temperature coefficient of that permeability.

Normally, the medium which contains the embryos cools below the freezing point without ice crystal formation, a phenomenon referred to as supercooling. Then at some lower temperature ice nucleation occurs, followed by a rapid rise in temperature due to the release of latent heat of fusion[74]. To avoid extensive supercooling, crystallization is induced in the extracellular medium some 2°C below the freezing point of the solution by seeding the medium with an ice crystal. However, water in the cells of the embryo and between the ice crystals outside the embryo does not freeze at this temperature. This is primarily because of the solutes in the water lowering the freezing point. During further cooling and enlargement of ice crystals, the solute concentration rises and the embryo responds osmotically by losing water into the extracellular unfrozen medium.

Cells are injured during freezing and thawing primarily by solution effects and intracellular ice formation[74]. At high cooling rates the dehydration of the cell falls behind that of the solution and intracellular ice forms. Intracellular ice is especially deterimental when relatively large amounts of large crystals form. To avoid intracellular freezing, embryos must be cooled at 1°C/min or slower. However, too low a rate of cooling can also damage cells by what has been referred to as solution effect. This is especially harmful if cells are not allowed to rehydrate during thawing.

The required thawing rate depends on the freezing regimen used. When embryos are cooled slowly to temperatures betwen -27°C and -40°C and then rapidly to -196°C, thawing must be rapid (about 200°C/min). Cells treated in this way may contain some intracellular ice, and thawing has to be rapid to prevent injury from the recrystallization of that ice. On the other hand, if embryos are cooled slowly to temperatures below -60°C before transfer to liquid nitrogen, then thawing is normally done slowly at about (20°C/min)[74]. Although both systems result in similar rates of survival, the more rapid techniques of freezing and thawing are preferred for field work.

Embryos are normally stored in liquid nitrogen at -196°C. The only reactions that occur at -196°C are direct ionizations from background radiation. Consequently, storage times of 200 years or so are unlikely to produce any detectable reduction in the survival of frozen embryos or cause genetic change[74].

Cryoprotectants such as glycerol or DMSO in concentrations ranging from 1.0 to 2.0 M are required to ensure embryo survival after freezing. It is thought that cryoprotectants act by reducing the amount of ice present at any temperature during freezing, thereby moderating the changes in solute concentration. Recommended criteria for a cryoprotectant include high solubility, low toxicity at high concentrations, and a low molecular weight both for easier permeation and to exert a maximum colligative effect[74].

During the addition and dilution of a permeating cryoprotectant, the cell undergoes osmotic changes in cell size. As a consequence, if the addition or particularly the dilution are carried out inappropriately, the viability of cells can be affected [74]. Equations which model the influx and efflux of cryoprotectants in cells can be used to calculate the optimum procedure and to design the most practical addition and removal method. Most investigators add the cryoprotectant stepwise, typically in 0.25 M steps. In contrast, there is clear evidence that the rate of removal of cryoprotectants is critical. The standard, empirical, method is to dilute it by step-wise addition of PBS or to pipette the embryos into decreasing concentrations of cryoprotectant solution, eg. 0.25 M steps.

Leibo and Mazur suggested a modification in the procedure of cryoprotectant removal by including nonpermeable solutes like sucrose into the dilution medium [76]. The sucrose acts as an osmotic counterforce to restrict water movement across the membranes. As the cryoprotectant leaves the embryo, it will shrink in response to the extracellular hypertonic dilution medium. It regains its normal volume when at the end of the process the embryo is placed in normal isotonic culture medium. Using this information, practical methods of quickly removing glycerol from thawed embryos have been devised [77,78]. As a result, a one-step straw has been developed so that embryos can be thawed, solutions mixed within the straw and transfer done nonsurgically to the recipient.

Freeze - Thaw Procedures

The following protocol has been proposed for the cryopreservation of day-7 bovine embryos in PBS supplemented with pyruvate, glucose, FCS and glycerol (1.0 M to 1.5 M) [74]. Embryos are pipetted into the freezing medium at room temperature (20°C) and kept for 8-10 minutes to permit the glycerol to equilibrate. During this equilibration period the embryo(s) are transferred in volumes of 0.2 to 0.5 ml of freezing medium into vials or French straws which are then securely sealed. The samples can be immediately transferred into the freezing chamber at -7°C and held for 5 minutes. Crystallization (seeding) of the extracellular medium is initiated by touching the outside wall of the straw or vial with cold forceps precooled in liquid nitrogen. The samples are kept at the seeding temperature for 5-10 min to allow the crystallization of the medium to progress to equilibrium. Next embryos are cooled at 0.3° to 0.8°C/min to between -30°C and -40°C, at which time they are immersed into liquid nitrogen and stored.

Thawing is carried out by placing the straw or vial into a waterbath at 20°C or 37°C, respectively. Different temperatures are used for French straws and vials to compensate for the differences in the sample surface to volume ratio.

The cryoprotectant must be removed without causing osmotic damage. The method of choice is dilution in a sucrose-PBS medium. A sucrose solution approximately isosmolal with the glycerol is added to the freezing medium at room temperature in a volume ratio of 10:1 for about 5-10 minutes. Alternatively, embryos are moved through decreasing concentrations of glycerol in 0.25 M steps of 10 minutes each. The embryos are then pipetted into PBS culture medium and evaluated prior to transfer.

Success Rates

Similar procedures have resulted in the successful freezing of morula and blastocysts from cattle, goats, sheep and horses[74]. Freezing of earlier embryonic stages of farm animals, unlike that of laboratory animals, has been unsuccessful. For example, pig zygotes do not even survive cooling to temperatures below +10°C. This high temperature sensitivity of the early developmental stages may be associated with the presence of large amounts of lipids in the cells[74]. The sensitivity of the early stages as well as differences between species could also be related to differences in permeability to water or to the cryoprotectant. Mouse oocytes for example, have lower permeabilities to glycerol than do later stages[74]. Retarded or degenerating embryos and embryos with cracked or broken zona survive present freezing techniques very poorly.

Survival rates of cryopreserved embryos are steadily improving. Only a few years ago pregnancy rates from transferred frozen-thawed bovine embryos was about half of that obtained from transferred nonfrozen embryos. At present, overall pregnancy rates of 40% are being reported for frozen-thawed cattle embryos[74]. However, unless all steps are controlled closely, pregnancy rates from day 7 bovine embryos may vary considerably among different donors. The extent of variation can be a important factor in the cost effectiveness of a program.

MICROSURGICAL PROCEDURES AND GENETIC ENGINEERING

Genetic engineering might be narrowly defined as modification of the chemical structure of DNA or RNA. However, Ruttedge and Seidel have broadened the definition to include any directed change in the genetic makeup of a population[79]. A.I. and embryo transfer are clearly useful tools for genetic engineering. Microsurgery of the embryo is yet another generation of genetic engineering which could have profound effects on animal breeding.

In Vitro Fertilization

Chang[80] was the first to unequivically demonstrate success with *in vitro* fertilization. He transferred fertilized rabbit ova to recipients and obtained appropriately genetically-marked offspring. The production of young from *in vitro* fertilization has now been accomplished in eight species, but only in the mouse, rabbit, and human have more than a few dozen young been produced[46,81,82].

The most difficult aspect of *in vitro* fertilization is capacitation of sperm. Ejaculated mammalian spermatozoa seem to be incapable of fertilizing ova until they are capacitated, a process that normally takes place in the female reproductive tract over a variable period of time, depending on the species. Capacitation has also been accomplished *in vitro* in many species[83].

In vitro fertilization with mouse gametes represents the most studied, most successful and best defined model of mammalian *in vitro* fertilization. Epididymal sperm can be capacitated *in vitro* in one hour and sperm penetration rates are in excess of 80%[84,85]. Procedures for *in vitro* fertilization with rat gametes are similar to those with mice. Although procedures for hamsters

are more defined on a biochemical basis, methods of culture of 1-cell hamster ova are much more difficult [86]. *In vitro* fertilization with rabbit gametes is a completely different process than for rodents because rabbit sperm are much more difficult to capacitate *in vitro*. However, many investigators have now produced young from rabbit ova fertilized *in vitro* [87].

The procedures used for *in vitro* fertilization in farm animals have been reviewed [46,81,82]. The most common measure of fertilization is division to the 2-cell stage, but parthenogenesis and fragmentation of the ovum are difficult to distinguish from cell division of fertilized embryos. The recent birth of a genetically marked calf was the first unequivocal evidence of successful *in vitro* fertilization in farm animals [88]. It may be some years before *in vitro* fertilization with gametes of domestic animals becomes a routine procedure. However, this initial success has demonstrated its feasibility and the various potential applications are overwhelming.

Prenatal Sex Selection

Although considerable research effort has been directed toward sexing sperm over the past several years, there seems to be no reliable methods available at this time. The potential application of sperm sexing, especially in humans and cattle make this an intense area of research. The control of sex prior to fertilization is certainly preferrable to control after fertilization. However, the embryo seems to be a more likely candidate for sexing at this time. Female rabbit embryos were reliably sexed on the basis of sex chromatin in biopsied trophoblast cells as early as 1968 [89]. Since then, numerous investigators have successfully sexed mammalian embryos on the basis of the karyotype of biopsied cells [90]. However, biopsy and karyotyping procedures are tedious, time-consuming and relatively inaccurate, making them impractical for routine commercial use.

An alternative in the sexing of embryos is to use an antibody to the H-Y antigen, a protein found on the cell membrane of male mammalian cells [91,92]. The 8-cell embryo apparently has sufficient H-Y antigen for detection if the ovum was fertilized by a Y-bearing sperm. Antibodies to H-Y antigen bind to the male embryos which are then detected by one of two methods [92]. The first is to add complement, which results in death of the male embryos. The more practical method is the second antibody method which consists of producing a fluorescent-labelled antibody to the first antibody so that the male embryos will fluoresce in appropriate light. This procedure was about 80% accurate for sexing mouse embryos [92] and is being developed by several companies for use with bovine embryos [93].

Micromanipulation

The simplest method of making identical twins is to separate the cells of 2-cell embryos and allow each half to develop independently. Half and quarter embryos have also been used to produce identical quadruplet sheep, triplet cattle, and twin horses and pigs [94,95]. Success rates are fairly high for identical twins but drop off considerably when identical quadruplets were attempted. However, identical quintuplets have been produced by mixing cells of 4- and 8-cell embryos. The blastomeres of the 8-cell embryo apparently developed into fetuses while those of the 4-cell embryos formed placentas [29,95].

A simpler method of producing identical twins from morulae and early blastocysts involves the microsurgical division of the embryo into two groups of cells followed by immediate embryo transfer [98,97]. In some cases, surrogate zona pellucidae are used, although this may not be necessary. This procedure takes approximately 10 minutes per embryo, and can be applied during embryo transfer procedures providing proper equipment and appropriately trained personnel are available. Pregnancy rates of 50% or more per demi-embryo were reported in cattle, which results in a net pregnancy rate in excess of 100% per original embryo.

Methods of making identical multiplets are, in many respects, methods of cloning, as genetically identical animals are produced asexually. Sometimes cloning is defined in a more narrow sense such as nuclear transplantation. Nuclear transplantation was accomplished successfully in a 1-cell mouse ova utilizing the donor nucleus of an embryonic cell [98]. Although very few mice have been born as a result of such procedures, one could theoretically make hundreds of genetically identical animals in this way by serial nuclear transplantation.

Androgenesis, Gynogenesis and Parthenogenesis

Androgenesis refers to reproduction without a nuclear genetic contribution from the female and gynogenesis to reproduction without a genetic contribution of the male, although a sperm may activate the oocyte [99]. Parthenogenesis is a special case of gynogenesis, in which males are not involved at all. The simplest example of androgenesis would be to fertilize an ovum with two sperm and to remove the female genetic material [29]. Alternately, sperm may be injected directly into the oocyte [100]. If both haploid genetic complements came from the same animal, the process is termed "selfing" and results in 50% inbreeding. Another method of androgenesis or gynogenesis could be accomplished by pronuclear removal and fusion [101].

In simplest terms, diploid parthenogenesis can be accomplished by fertilizing an ovum with another ovum instead of a sperm [29]. Another method would be to suppress second polar body formation, or fertilize the ovum with the second polar body. Development to term has never been observed. However, nuclei from parthenogenetic blastocysts that were transplanted into 1-cell ova resulted in development to term [102].

Chimeras

One of the most powerful embryological techniques ever devised is aggregation of cells of two or more preimplantation embryos to produce offspring that have cells from more than one cell line. The most common procedure is to aggregate two 4-cell mouse embryos which would result in a tetraparental mouse [99]. Another method is to inject cells of one embryo into the blastocoelic cavity of another [103]. Although some of the chimeric animals so produced are likely to be useful, by chance, there is no way at this time of ensuring that the intended genotype is incorporated into the embryo. The numbers of other possibilities with the production of chimeras are almost limitless. Considerable future research effort will undoubtedly be conducted in this area.

Addition or Modification of DNA

Recently, in two separate studies, the DNA for rabbit beta-globulin[104] and for rat growth hormone[105], was injected into pronuclei of 1-cell fertilized mouse ova. In some instances, the injected DNA was integrated into the genome and expressed and transmitted to future generations. This procedure permits modification of genetic material in a fundamentally different way from conventional procedures. One might add genes for anatomical and production traits or disease resistance, directly to embryos rather than breeding for it by selection methods. Furthermore, genetic DNA does not seem to be species specific[104,105]. Genetic engineering utilizing this technology has great potential in animal production schemes.

Future Considerations

The sciences associated with genetic engineering technology are advancing at a rate that is practically inconceivable. The limits of this technology seems only to be bound by ones imagination. For example, sperm injection techniques, nuclear transplantations and the manipulation of individual genes and chromosomes are potentially very useful in animal breeding schemes. Further, utilizing the techniques associated with the production of chimeras, the possibilities of interspecies transfers and the salvage of endangered species may be possible. Whereas cloning is likely to only produce a copy of a genetically desireable animal, techniques associated with genes and DNA have the potential of producing a so-called super animal. As research tools the value of genetic engineering techniques are virtually limitless.

Seidel points out that genetic engineering may be overrated as a short-term means of improving animal production[99]. For example, fewer than 5% of beef cows in North America conceive by A.I. although this is proven technology that is inexpensive and easy to apply relative to most genetic engineering techniques. Because a technology is available, does not mean that it will be widely applied. However, a few spectacular successes are bound to capture the imagination of some and the incentive to apply these techniques in animal production schemes will be there. It is unlikely that anyone would have predicted 10 years ago that embryo transfer technology would have evolved to where it is today.

REFERENCES

1. Bradford, G.E. and Kennedy, B.W. 1980. Genetic aspects of embryo transfer. Theriogenology. 13: 13-26.

2. McDaniel, B.T. and Cassell, B.G. 1981. Effects of embryo transfer on genetic change in dairy cattle. J. Dairy Sci. 64: 2484-2492.

3. Land, R.B. and Hill, W.G. 1975. The possible use of superovulation and embryo transfer in cattle to increase response to selection. Anim. Prod. 21: 1-12.

4. Church, R.B. and Shea, B.F. 1977. The role of embryo transfer in cattle improvement programs. Can. J. Anim. Sci. 57: 33-45.

5. Wilmut, I. 1982. Applications of egg transfer to animal production, breeding and research. In: Mammalian Egg Transfer. Cyril E. Adams (ed.) CRC Press Inc., Boca Raton, Florida. p. 211-230.

6. Seidel, George, E. Jr., 1981. Superovulation and embryo transfer in cattle. Science 211: 351-358.

7. Seidel, George, E. Jr., and Seidel, Sarah, M. 1981. The embryo transfer industry. In: New Technologies in Animal Breeding. B.G. Brackett, G.E. Seidel and S.M. Seidel (eds.). Academic Press, New York. p. 41-80.

8. Powell, R.L. 1981. Possible effects of embryo transfer on evaluation of cows and bulls. J. Dairy Sci. 64: 2476-2483.

9. Durrant B., and Benirschke, K. 1981. Embryo transfer in exotic animals. Theriogenology. 15: 77-84.

10. Johnson, J.L., Leipold, H.W., Snider, G.W. and Baker, R.D. 1980. Progeny testing for bovine syndactyly. J. Am. Vet. Med. Assoc. 176: 549-554.

11. Sreenan, J.M. 1977. Embryo transfer for the induction of twinning in cattle. In: Embryo Transfer in Farm Animals. K.J. Betteridge (ed.). Agriculture Canada, Ottawa. Monograph 16. p. 62-66.

12. Bellows, R.A. and Short, R.E. 1972. Superovulation and multiple births in beef cattle. J. Anim. Sci. 34 (Supp. 1): 67-79.

13. Bellows, R.A., Short, R.E. and Staigmiller, R.B. 1979. Research areas in beef cattle reproduction. In: BARC Symposium III - Animal Reproduction. H.W. Hawk, C.A. Keddy, and H.C. Cecil (eds.). A Halsted Press Book. John Wiley and Sons. New York. p. 3-18.

14. Rowson, L.E.A., Lawson, R.A.S. and Moor, R.M. 1971. Production of twins in cattle by egg transfer. J. Reprod. Fert. 25: 261-268.

15. Anderson, G.B. 1978. Methods of producing twins in cattle. Theriogenology. 9:3-16.

16. Gordon, I. and Boland, M.P. 1979. Embryo transfer and twinning in cattle. Vet. Sci. Comm. 3:177-186.

17. Seidel, G.E. Jr. 1982. Applications of microsurgery to mammalian embryos. Theriogenology. 17: 23-34.

18. Singh, E.L. and Hare, W.C.D. 1984. Embryo-Pathogen Interactions. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.). W.B. Saunders Co. Philadelphia. (In press).

19. Eaglesome, M.D., Hare, W.C.D., and Singh, E.L. 1980. Embryo transfer: A discussion on its potential for infectious disease control based on a review of studies on infection of gametes and early embryos by various agents. Can. Vet. J. 21: 106-112.

20. Singh, E.L., Hare, W.C.D., Thomas, F.C., Mitchell, D., Eaglesome, M.D. Randall, G.C.B., Bouillant, A.M.P., Betteridge, K.J., Samagh, B.S., and Bielanski, A. 1982. Disease control through embryo transgfer. Proc. Int. Cong. Embryo Transfer in Mammals. Annecy, France (In press).

21. Martin, P.A. 1983. Commercial embryo transfer in swine: Who is interested in it and why. Theriogenology. 19: 43-48.

22. Bowen, R.A., Elsden, R.P., and Seidel, G.E. Jr. 1978. Embryo transfer for cows with reproductive problems. J. Am. Vet. Med. Assoc. 172: 1303-1306.

23. Elsden, R.P., Nelson, L.D., and Seidel, G.E. Jr. 1979. Embryo transfer in fertile and infertile cows. Theriogenology. 11:17-26.

24. Mapletoft, R.J., Johnson, W.H., and Miller, D.M. 1980. Embryo transfer techniques in handling repeat breeding cows. Theriogenology. 13: 103.

25. Johnson, W.H. 1984. Embryo transfer in repeat breeder cows. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.)., W.B. Saunders Co., Philadelphia. (In press).

26. Douglas, R.H. 1984. Equine embryo transfer. In: Current Therapy in Theriogenology II. D.A. Morrow (ed) W.B. Saunders Co., Philadelphia. (In press).

27. Mapletoft, R.J., Johnson, W.H. and Miller, D.M. 1980. Effects of a progestagen ear implant on superovulatory response in the cow. Theriogenology 13: 102.

28. Sreenan, J.M. 1983. Embryo transfer procedure and its use as a research technique. Vet. Rec. 112: 494-500.

29. Seidel, G.E. Jr. 1983. Mammalian oocytes and preimplantation embryos as methodological components. Biol. Reprod. 28: 36-49.

30. Elsden, R.P. 1980. Bovine embryo transfer. Proc. Soc. for Therio. Omaha, Nebraska. p. 101-133.

31. Foote, R.H. and Onuma, H. 1970. Superovulation, ovum collection, culture and transfer: a review. J. Dairy Sci. 53: 1681-1692.

32. Phillippo, M. and Rowson, L.E.A. 1975. Prostaglandins and superovulation in the bovine. Ann. Biol. Anim. Bioch. Biophys. 15: 233-240.

33. Sreenan, J.M. and Gosling, J.P. 1977. The effect of cycle stage and plasma progesterone level on the induction of multiple ovulations in heifers. J. Reprod. Fert. 50: 367-369.

34. Rowson, L.E. 1951. Methods of inducing multiple ovulation in cattle. J. Endocrinol. 7:260-270.

35. Newcomb, R., Christie, W.B., Rowson, L.E.A., Walters, D.E. and Bousfield, W.E.D. 1979. Influence of dose, repeated treatment and batch of hormone on ovarian response in heifers treated with PMSG. J. Reprod. Fert. 56: 113-118.

36. Mapletoft, R.J. 1980. Embryo transfer for the practitioner. Proc. 13th Ann. Meet. Am. Assoc. Bovine Pract. Toronto, Canada. p. 154-162.

37. Chupin, D. and Procureur, R. 1983. Efficiency of pituitary extracts (FSH) for inducing of superovulation in cattle. Anim. Reprod. Sci. 6:11-23.

38. Elsden, R.P., Nelson L.D. and Seidel, G.E. Jr. 1978. Superovulation of cows with follicle stimulating hormone and pregnant mare's serum gonadotrophin. Theriogenology. 9:17-26.

39. Elsden, R.P. 1977. Embryo collection by surgical methods. In: Embryo Transfer in Farm Animals. K.J. Betteridge (ed.) Agriculture Canada, Ottawa. Monograph 16. p. 10-13.

40. Rowe, R.F., Del Campo, M.R., Eilts, C.L., French, L.R., Winch, R.P. and Ginther, O.J. 1976. A single cannula technique for nonsurgical collection of ova from cattle. Theriogenology 6:471-484.

41. Drost, M., Brand, A. and Aarts, M.H. 1976. A device for nonsurgical recovery of bovine embryos. Theriogenology. 6: 503-508.

42. Elsden, R.P., Hasler, J.F. and Seidel, G.E. Jr. 1976. Non-surgical recovery of bovine eggs. Theriogenology. 6:523-532.

43. Pugh, Anne, Trounson, A.O., Aarts, M.H. and McPhee, S. 1980. Bovine embryo recovery by filtration of non-surgical flushings. Theriogenology. 13: 281-286.

44. Wright, R.W. Jr. 1984. Culture and short term storage of embryos. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.) W.B. Saunders Co., Philadephia. (In press).

45. Lindner, G.M., Anderson, G.B., BonDurant, R.H. and Cupps, P.T. 1983. Survival of bovine embyros stored at 4°C. Theriogenology 20: 311-320.

46. Wright, R.W. Jr., and Bondioli, K.R. 1981. Aspects of in vitro fertilization and embryo culture in domestic animals. J. Anim. Sci. 53: 702-729.

47. Shea, B.F. Evaluating the bovine embryo. Theriogenology. 15: 31-42.

48. Lindner, G.M. and Wright, R.W. Jr. 1983. Bovine embryo morphology and evaluation. Theriogenology. 20: 407-416.

49. Whittingham, D.G. 1981. Viability assays. In: Frozen Storage of Laboratory Animals. G.H. Zeilmaker (ed.). Gustav Fischer. Stuttgart-New York. p. 95-99.

50. Elsden, R.P. 1977. Embryo transfer by surgical methods. In: Embryo Transfer in Farm Animals. K.J. Betteridge (ed.). Agriculture Canada, Ottawa. Monograph 16. p. 27-28.

51. Rowe, R.F., Del Camp, M.R., Critser, J.K., and Ginther, O.J. 1980. Embryo transfer in cattle: Nonsurgical transfer. Am. J. Vet. Res. 41: 1024-1028.

52. Wright, J.M. 1981. Non-surgical embryo transfer in cattle. Theriogenology 15: 43-56.

53. Newcomb, R. and Rowson, L.E.A. 1980. Investigation of physiological factors affecting non-surgical transfer. Theriogenology. 13: 41-50.

54. BonDurant, R.H. 1984. Embryo transfer in sheep and goats. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.). W.B. Saunders Co., Philadelphia. (In press).

55. Betteridge, K.J. and Moore, N.W. 1977. Superovulation. In: Embryo Transfer in Farm Animals. K.J. Betteridge (ed.). Agriculture Canada. Ottawa. Monograph 16, p. 37-38.

56. Armstrong, D.T. and Evans, G. 1983. Factors influencing success of embryo transfer in sheep and goats. Theriogenology. 19: 31-42.

57. Armstrong, D.T., Pfitzner, A.P., Warnes, G.M., Ralph, M.M. and Seamark, R.F. 1983. Endocrine responses of goats after induction of superovulation with PMSG and FSH. J. Reprod. Fert. 67: 395-401.

58. Trounson, A.O. and Moore, N.W. 1974. Fertilization in the ewe following multiple ovulations and uterine insemination. Aust. J. Biol. Sci. 27: 301-304.

59. Evans, G., and Robinson, T.J. 1980. The control of fertility in sheep: endocrine and ovarian responses to progestagen - PMSG treatment in the breeding season and in anestrus. J. Agric. Sci. 94: 69-88.

60. Hunter, G.L., Adams, G.E. and Rowson, L.E.A. 1955. Interbreed ovum transfer in sheep. J. Agric. Sci. 46: 143-149.

61. Averill, R.L.W., Adams, C.E. and Rowson, L.E.A. 1955. Transfer of mammalian ova between species. Nature (Lond.) 176: 167-168.

62. Otsuki, K. and Soma, T. 1964. Transfer of fertilized ova through the cervix in the goat. Nat. Instit. Anim. Ind. Chiba, Japan. Bull. 6: 27-32.

63. Moore, N.W. and Shelton, J.N. 1964. Egg transfer in sheep. Effect of degree of synchronization between donor and recipient, age of egg and site of transfer on the survival of transferred eggs. J. Reprod. Fert. 7: 145-152.

64. Rowson, L.E.A., and Moor, R.M. 1966. Embryo transfer in the sheep: the significance of synchronizing oestrus in the donor and recipient animal. J. Reprod. Fert. 11: 207-212.

65. Martin, P.A. 1984. Embryo transfer in swine. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.) W.B. Saunders Co., Philadelphia. (In press).

66. Rampacek, G.B. and Kraeling, R.R. 1978. Effect of estrogen on luteal function in prepuberal gilts. J. Anim. Sci. 46: 453-457.

67. Melampy, R.M. and Anderson, L.L. 1968. Role of uterus in corpus luteum function. J. Anim. Sci. 27 (Supp. 1): 77-96.

68. Smith, A.U. 1952. Behavior of fertilized rabbit eggs exposed to glycerol and to low temperatures. Nature (Lond.) 170: 374-375.

69. Whittingham, D.G., Leibo, S.P. and Mazur, P. 1972. Survival of mouse embryos to -196 and -269°C. Science. 178: 411-414.

70. Bank, H. and Maurer, R.R. 1974. Survival of frozen rabbit embryos. Exp. Cell Res. 89: 188-196.

71. Wilmut, I. and Rowson, L.E.A. 1973. Experiments on the low-temperature preservation of cow embryos. Vet. Rec. 92: 686-690.

72. Willadsen, S., Polge, C., and Rowson, L.E.A. 1978. The viability of deep-frozen cow embryos. J. Reprod. Fert. 52: 391-393.

73. Maurer, R.R. 1978. Freezing mammalian embryos: A review of the techniques. Theriogenology. 9: 45-68.

74. Schneider, U. and Mazur, P. 1984. Implications and applications of the long-term preservation of embryos by freezing. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.). W.B. Saunders Co., Philadelphia (In press).

75. Schneider, U. and Maurer, R.R. 1983. Factors affecting survival of frozen-thawed mouse embryos. Biol. Reprod. 29: 121-128.

76. Leibo, S.P. and Mazur, P. 1978. Methods for the preservation of mammalian embryos by freezing. In: Methods in Mammalian Reproduction. J.C. Daniel

(ed.). Academic Press, New York. p. 179-201.

77. Leibo, S.P. 1983. Field trial of one-step frozen bovine embryos transferred non-surgically. Theriogenology. 19: 139.

78. Renard, J.P., Heyman, Y., Leymonie, P. and Plat, J.C. 1983. Sucrose dilution: A technique for field transfer of bovine embryos frozen in the straw. Theriogenology. 19: 145.

79. Rutledge, J.J. and Seidel, G.E. Jr. Genetic engineering and animal production. J. Anim. Sci. 57 (Supp. 2): 265-272.

80. Chang, M.C. 1959. Fertilization of rabit ova in vitro. Nature. 184: 466-467.

81. Brackett, B.G. 1981. Applications of in vitro fertilization. In: New Technologies in Animal Breeding. B.G. Brackett, G.E. Seidel, Jr., and S.M. Seidel (eds.). Academic Press, New York. p. 141-161.

82. Brackett, B.G. 1983. A review of bovine fertilization in vitro. Theriogenology 19: 1-15.83. Rogers, B.J. 1978. Mammalian sperm capacitation and fertilization in vitro: A critique of methology. Gamete Res. 1: 165-223.

83. Rogers, B.J. 1978. Mammalian sperm capacitation and fertilization in vitro: A critique of methology. Gamete Res. 1: 165-223.

84. Hoppe, P.C. and Pitts, S. 1973. Fertilization in vitro and development of mouse ova. Biol. Reprod. 8: 420-426.

85. Fraser, L.R. and Drury, L.M. 1975. The relationship between sperm concentration and fertilization in vitro of mouse eggs. Biol. Reprod. 13: 513-518.

86. Bavister, B.D., Leifried, M.L. and Lieberman, G. 1983. Development of preimplantation embryos of the golden hamster in a defined culture medium. Biol. Reprod. 28: 235-247.

87. Seidel, G.E. Jr., Bowen, R.A. and Kane, M.T. 1976. In vitro fertilization, culture and transfer of rabbit ova. Fertil. Steril. 27: 861-870.

88. Brackett, B.G., Bousquet, D., Boice, M.L., Donawick, W.J., Evans, J.F., and Dressel, M.A. 1982. Normal development following in vitro fertilization in the cow. Biol. Reprod. 27: 147-158.

89. Gardner, R.L. and Edwards,R.G. 1968. Control of sex ratio at full term in the rabbit by transferring sexed blastocysts. Nature. 218: 346-348.

90. Betteridge, K.J., Hare, W.C.D., and Singh, E.L. 1981. In: New Technologies in Animal Breeding. B.D. Brackett, G.E. Seidel, Jr., and S.M. Seidel (eds). Academic Press, New York. p. 109-125.

91. Krco, C.J. and Goldberg, E.H. 1976. H-Y (male) antigen: Detection on eight-cell mouse embryos. Science 193: 1134-1135.

92. White, K.L., Lindner, G.M., Anderson, G.B. and BonDurant, R.H. 1983. Cytolytic and fluorescent detection of H-Y antigen on preimplantation mouse embryos. Theriogenology. 19: 701-705.

93. Wachtel, S.S. 1984. H-Y antigen in the study of sex determination and control of sex ratio. Theriogenology 21: 18-28.

94. Willadsen, S.M., Lehn-Jensen, H., Fehilly, C.B., and Newcomb, R. 1981. The production of monozygotic twins of preselected parentage by micromanipulation of nonsurgically collected cow embryos. Theriogenology. 15: 23-30.

95. Willadsen, S.M. and Fehilly, D.B. 1983. The developmental potential and regulatory capacity of blastomeres from 2-, 4-, and 8-cell sheep embryos. In: Fertilization of the Human Egg In Vitro - Biological Bases and Clinical Applications. H.M. Beier, and H.R. Lindner (eds).Springer-Verlag, Berlin. p. 353

96. Ozil, J.P., Heyman, Y. and Renard, J.P. 1982. Production of monozygotic twins by micromanipulation and cervical transfer in the cow. Vet. Rec. 110: 126-127.

97. Williams, T.J., Elsden, R.P. and Seidel, G.E. Jr. 1983. Bisecting bovine embryos: Methods, applications and success rates. Proc. Ann. Conf. A.I. and Embryo Transfer in Beef Cattle. NAAB and IETS. Denver. p. 45-51.

98. Illmensee, K. and Hoppe, P.C. 1981. Nuclear transplantation in Mus musculus: Developmental potential of nuclei from preimplantation embryos. Cell. 23: 9-18.

99. Seidel, G.E. Jr. 1984. Genetic engineering. In: Current Therapy in Theriogenology II. D.A. Morrow (ed.). W.B. Saunders Co., Philadelphia. (In press).

100. Thadoni, V.M. 1980. A study of heterospecific sperm - egg interactions in the rat, mouse and deer mouse using in vitro fertilization and sperm injection. J. Exp. Zool. 212: 435-453.

101. McGrath, J. and Solter, D. 1983. Nuclear transplantation in the mouse embryoby microsurgery and cell fusion. Science. 220: 1300-

102. Hoppe, P.C. and Illmensee, K. 1982. Full-term development after transplantation of parthenogenetic embryonic nuclei into fertilized mouse eggs. Proc. Natl. Acad. Sci. 79: 1912-1916.

103. Gardner, R.L. 1978. Production of chimeras by injecting cells or tissue into the blastocyst. In: Methods in Mammalian Reproduction. J.C. Daniel Jr. (ed.). Academic Press, New York. p. 137-165.

104. Wagner, T.E., Hoppe, P.C., Jollick, J.D., Scholl, D.R., Hodinka, R.L. and Gault, J.B. 1981. Microinjection of a rabbit beta-globulin gene into zygotes and its subsequent expression in adult mice and their offspring. Proc. Natl. Acad. Sci. 78: 6376-6380.

105. Palmiter, R.D., Brinster, R.L., Hammer, R.E., Trumbauer, M.E., Rosenfeld, M.G., Birnberg, N.C. and Evans, R.M. 1982. Dramatic growth of mice that develop from eggs microinjected with metallothionein - growth hormone fusion genes. Nature. 300: 611-615.

EFFECTS OF WATER QUALITY ON LIVESTOCK PRODUCTIVITY*

Jerome Martin, Ph.D.

Water is not a nutrient, but an adequate supply of water is essential to the utilization and transport of nutrients, and the maintenance of proper body temperatures. Water comprises approximately 70% of total body weight. The majority of body water enters orally, either as a liquid or as part of the feed; only a small portion of body water originates from metabolic sources. Water is lost from the body via urine, feces, perspiration, respiration and lactation. The ability to reduce water losses during period of deprivation varies with species: Zebu cattle (Bos indicus) apparently produce drier feces and more concentrated urine than do European cattle (Bos taurus) (Kirkbride, 1973).

Estimates of the extra water requirement for lactation include 0.87 kg/kg milk produced (Winchester and Morris, 1956) and 0.90 kg/kg milk produced (Murphy et al., 1983).

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Water Requirements

Water consumption by cattle is directly related to feed consumption (Ritzman and Benedict, 1924) and ambient temperature (Winchester and Morris, 1956). Table 1 shows the effect of temperature on water consumption (per unit of dry matter consumed) for beef cattle.

TABLE 1

The Effect of Ambient Temperature on Water Intake of Beef Cattle (Winchester and Morris, 1956)

Ambient Temperature		Water Consumed
°C	°F	(kg/kg of dry matter consumed)
-12 to +4	10-40	3.1
4.4	40	3.1
10.0	50	3.4
15.6	60	3.8
21.1	70	4.5
26.7	80	5.2
32.2	90	7.3

The Agricultural Research Council (1965) stated that sheep would consume 2.0 kg of water per unit of dry matter intake (DMI) at temperatures up to 15°C, 2.5 kg/kg DMI at temperatures of 15-20°C and 3.0 kg/kg DMI at temperatures exceeding 20°C.

Conversely, if water availability is restricted, feed consumption is reduced.

Stockdale and King (1983) developed a model for the prediction of total water consumption by lactating dairy cows: Total water consumption (kg/cow/day = 11.34 + 4.63 dry matter intake (kg/cow/day) - 0.036 dry matter concentration (g/kg) + 0.84 mean temperature (°C).

Consumption of feed containing high levels of salts or protein increases water requirements, since an increased volume of urine is required to excrete excess salt and nitrogenous wastes.

Age also affects water requirements, since the bodies of younger animals contain more water than those of older animals. (Ageing is a process of dehydration!).

The average survival time of range cattle which are deprived of water is 4 to 5 days. The early clinical signs of severe dehydration include: decrease in feed consumption, constipation, loss of weight, increases in body temperature and heart rate, and increased viscosity of blood (Kirkbride, 1973).

Salts

Early work (1930) by Heller and Larwood on rats indicated that levels of 15,000 ppm of salts lowered growth rate while 10,000 ppm affected reproductive performance. Their findings with regard to the general additive effects of various salts, the physiological adjustment to highly saline waters and the higher resistance of older animals to salinity have since been confirmed in other species. In 1933, Heller suggested that 10,000 ppm of total salts was probably the upper limit which might be considered for a

maintenance ration for cattle. He also stated that chloride salts were apparently less harmful than sulphates, and alkalies were more dangerous than neutral mineral salts. He did say, however, that the total salt level was more important than the composition of the salt mixture.

In 1959, Embry and co-workers investigated the effects of sodium sulphate in water for fattening cattle. Twenty-four heifers weighing an average of 304 kg were allotted to four different groups, each of which was fed alfalfa hay, a corn-soybean meal mixture and a mineral supplement free-choice. Sodium sulphate was added to the water (containing 530 ppm of total salts) at the following rates: 10,000 ppm; 7,000 ppm; and 4,000 ppm. The levels of 4,000 ppm and 7,000 ppm did not affect rate of gain. The animals fed water containing 10,000 ppm of sodium sulphate were taken off the high sulphate water after 56 days. The water had caused severe scours as well as incoordination and rapid difficult respiration in two of the six animals. A third heifer died but the cause of death was unknown. The remaining five animals were given "control" water for the final 28 days of the test. Normal appetite and appearance returned rapidly. All levels of sodium sulphate reduced salt consumption. Consumption of the mineral mixture was reduced by the two highest levels of sodium sulphate. The 10,000 ppm level caused a dramatic decrease in water consumption.

Weeth and Hunter (1971) found that the consumption of water containing 5,000 ppm of sodium sulphate caused heifers to drink less and eat less than heifers provided with tap water or water containing 4,110 ppm of sodium chloride. During the 30-day feeding period, the total weight gains for the tap-water, sodium chloride and sodium sulphate water groups were 19, 22 and -15 kg, respectively. These data conflict somewhat with those of Embry and co-workers: but both trials pointed to the fact that sulphates are more

dangerous than chlorides. Embry and co-workers (1959) also compared waters with two levels (7,000 ppm and 10,000 ppm) of sodium chloride and two levels (7,000 and 10,000 ppm) of mixed salts with a control water. The salt mixtures contained sodium chloride, sodium sulphate and magnesium sulphate. In each case, 7,000 ppm of salts did not affect gain, feed consumption or apparent condition of the animals. The high levels (10,000 ppm) of both the sodium chloride and the mixed salts caused decreases in gain, but neither had the toxic effects of the 10,000 ppm of sodium sulphate in the previous experiment. The authors suggested that the toxic level of total salts in water for beef cattle was somewhere between 7,000 ppm and 10,000 ppm.

Weeth and co-workers in 1960 found that water containing 20,000 ppm of sodium chloride was definitely toxic to heifers while the only effects resulting from the use of water containing 10,000 ppm of sodium chloride were an increase of 52-80% in water consumption and a decrease in blood urea. The water containing 20,000 ppm caused severe anorexia, weight loss and, in two cases, collapse.

Peirce (1959) found that water containing 1.3% (13,000 ppm) of sodium chloride and 0.10% (1,000 ppm) of magnesium chloride had no adverse effects on wethers. In a subsequent paper (1968), however, Peirce suggested that ewes and lambs may be less tolerant to saline waters than wethers. He suggested a maximum safe limit of 1% (10,000 ppm) of salts where the salts were high in chlorides and a safe limit of 0.50% (5,000 ppm) where the salts were high in bicarbonates.

Murphy *et al*. (1983), using multiple linear regression analysis, estimated that water intake increased by 50 $\pm$ 23 ml for each additional g of sodium fed in a trail where the basal diet contained 0.233% sodium. (Extra sodium was added as $NaHCC_3$.)

Weeth (1973) suggested the following tolerances:

TABLE 2

Tolerances for Cattle For Some Water Contaminants

	Tolerance (mg/L)
Manganese	500
Sodium	4,000
Bicarbonate	3,600
Chloride	6,000
Fluoride	10
Nitrate	4,000
Sulphate	2,500
Total Dissolved Solids	10,000*

* As sodium chloride

Bowland (1972) stated that when evaluating water for pigs, there is no need to distinguish between sources of salts: "Any combination of salts to a level of 5,000 ppm is acceptable for all pigs with levels to 7,000 ppm acceptable for growing and finishing pigs." He said that pigs may scour for a few days when first introduced to a new source of water and that very young pigs may be less able to adapt to higher salt levels.

Howell (1972) suggested maximum levels of salts for poultry:

TABLE 3

Suggested Evaluation for Drinking Water For Poultry in Alberta

Total Salts in Drinking Water	Evaluation
0 - 1500 ppm	Excellent quality for all classes of poultry
1500 - 3000 ppm	Satisfactory for all classes of poultry except for poults under three weeks of age
3000 - 4000 ppm	Not satisfactory for chicks, poults or ducklings. Satisfactory for laying hens and turkeys
4000 - 7000 ppm	Unsatisfactory for chicks, poults or ducklings. Increase water consumption and increase in watery droppings in hens and turkeys
Over 7000 ppm	Unsatisfactory for all classes of poultry

Nitrate

The presence of nitrate (NO_3) in water is due to the contamination of the water by organic material. Nitrate consumed by a ruminant is readily reduced to nitrite in the rumen, nitrite oxidizes hemoglobin to methemoglobin and reduced production or even death may result. Weeth (1973) cites work which indicates that water containing less than 4,000 mg/L of NO_3 is not likely dangerous to cattle and sheep.

Herrick (1974) suggests that the upper limit of NO_3 for animals be 100 ppm (ten times the upper level for humans, 10 ppm).

Water Quality For Humans

Most of us think of water quality for humans in relation to:

1) high nitrate levels as hazards to babies,
2) the terrible taste of water, tea and coffee in some areas,
3) the profound physiological effects which arise from the consumption of high-salt waters when one is unaccustomed to them (1)

However, there is some new information available on a possible relationship between 'coronary deaths' in humans and water hardness (Greathouse and Osborne, 1980; Hewitt and Neri, 1980). While there is an apparent inverse relationship between calcium and magnesium levels and incidence of coronary deaths, the researchers are not certain that this is a causal relationship. More research is being done in this area.

Williamson (1981), using epidemiological studies, concluded that drinking water containing trihalomethanes increases the risk of bladder, colon and rectum cancer.

Conclusions

The most important criterion used in evaluating water quality is the amount of total dissolved salts (salts). The total amount of salts present in water is apparently much more important than the types of salts contained. However, little is known about the actions and interactions of individual salts in naturally occurring waters.

Beef cattle, growing and finishing swine, and adult poultry can apparently consume water containing up to 7,000 parts per million of total salts with no ill effects. Water containing up to 5,000 ppm of total salts is satisfactory for all swine. Waters containing 1,500 - 3,000 ppm of salts are satisfactory for all classes of poultry with the exception of turkey poults under three weeks of age which should receive water containing less than 15,000 ppm. Ducks should receive water containing less than 4,000 ppm of total salts.

References

AGRICULTURAL RESEARCH COUNCIL. 1965. The Nutrient Requirements of Farm Livestock. No. 2. Ruminants. H.M. Stationery Office, 49 High Holborn, London, W.C.1.

BOWLAND, J.P. 1972. Water Quality for Pigs. In Water Quality For Livestock in Alberta. Alberta Agriculture. pp. 2-7.

EMBRY, L.B., HOELSCHER, M.A., WAHLSTROM, R.C., CARLSON, C.W., KRISTA, G.F. and OLSEN, O.E. 1959. Salinity and Livestock Water Quality. S. Dak. Agr. Exp. Sta. Bul. 481.

GREATHOUSE, D.G. and OSBORNE, R.H. 1980. Preliminary report on nationwide study of drinking water and cardiovascular diseases. Journal of Environmental Pathology and Toxicology, 4-2, 3 : 65-76.

HELLER, V.G. and LARWOOD, C.H. 1930. Saline Drinking Water. Science 71 : 223-224.

HERRICK, J.B. 1974. Water quality for livestock. Veterinary Medicine/Small Animal Clinician 69 : 469-473.

HEWITT, D. and L.C. NERI. 1980. Development of the Water Story: Some Recent Canadian Studies. Journal of Environmental Pathology and Toxicology 4-2, 3 : 51-63.

HOWELL, J. 1972. Water quality for poultry. In Water Quality For Livestock in Alberta. Alberta Agriculture. pp. 2-7.

KIRKBRIDE, C.A. 1973. Water deprivation in cattle. Water-Animal Relations Proceedings. pp. 49-54.

MARTIN, P.J. 1972. Water requirements of ruminants. In Water Quality For Livestock in Alberta. Albert Agriculture. pp. 13-21.

MURPHY, M.R., DAVIS, C.L. and McCOY, G.G. 1983. Factors affecting water consumption by Holstein cows in early lactation. J. Dairy Sci. 66 : 35-38.

PEIRCE, A.W. 1959. Studies on salt tolerance of sheep. II The tolerance of sheep for mixtures of sodium chloride and magnesium chloride in the drinking water. Aust. J. Agric. Res. 10 : 725-735.

PEIRCE, A.W. 1968. Studies on salt tolerance of sheep. VII The tolerance of ewes and their lambs in pens for drinking waters of the types obtained from underground sources in Australia. Aust. J. Agric. Res. 19 : 577-587.

RITZMAN, E.G. and BENEDICT, F.G. 1924. The effect of varying feed levels on the physiological economy of steers. New Hamp. Sgr. Exp. Sta. Tech. Bul. No. 26.

STOCKDALE, C.R. and K.R. KING. 1983. A note on some of the factors that affect the water consumption of lactating dairy cows at pasture. Anim. Prod. 36 : 303-306.

WEETH, H.J. 1973. Non-applicability of federal water quality standards when applied to cattle. Water-Animal Relations Proceedings. pp. 9-14.

WEETH, H.J., LESPERANCE, A.L. and BOHMAN, N.R. 1968. Intermittent saline watering of growing beef heifers. J. Anim. Sci. 27 : 739-744.

WEETH, H.J. and HUNTER, J.E. 1971. Drinking of sulfate water by cattle. J. Ani. Sci. 32 : 277-281.

WILLIAMSON, S.J. 1981. Epidemiological studies on cancer and organic compounds in U.S. drinking waters. The Science of the Total Environment 18 : 187-203.

WINCHESTER, C.F. and MORRIS, M.J. 1956. Water intake rates of cattle. J. Anim. Sci. 15 : 722-740.

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The dairy industry of Manitoba is a challenging industry. The management decisions faced each day by to-day's producer have a direct result on the economic viability of his operation. Changing concepts on herd management, milking techniques and financial management demand that producers stay in touch with new dynamic opportunities. New medications, feed-stuffs and equipment can offer a bewildering variety of choices to the modern producer. Add to this; larger herd size, increasing use of hired labour and the resulting loss of attention to the individual cows and you become aware of the challenges the producer faces to maintain economic milk production.

Like all good business-men, the dairy producer looks to advice from various inputs before settling on his final decision. In the past this out-side input has come mainly from government personnel, product sales staff or the neighbour down the road. While all of these sources can be useful there are certain short-comings to each of them.

Most government staff involved in extention work are well-trained. However due to the relatively small number of extention people speciallizing in dairy, there is often a lack of continuity to the producer contact. The government dairy specialist may be called upon due to a specific feeding problem for example and in all probability will set out a good program to rectify the situation. But due to time restraints in many cases it is nearly impossible for the extention person to do the necessary follow-up work with the individual to ensure he is correctly putting the program in place or if the circumstances have in fact changed and there-fore alter the program.

Another factor involved with this lack of individual attention due to time restraints is the validity of certain recommendations coming from the extention offices. Most feed rations coming from the department for example are based on the ration analysis and information supplied by the producer. For example a producer may say he is feeding "X" number of pounds of a certain haylage to so many cows in a free- stall barn. Based on the analysis the nutritionist then recommends certain levels of added ingredients in order to balance the ration. But there are numerous factors that affect the accuracy and the results of these recommendations. Did the producer take a representative sample of haylage? Did he weigh the haylage in order to correctly determine consumption of the cattle? Would there in fact be a more economical way of feeding the herd by feeding

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a different combination of forages? Again all of these factors can affect the recommendati but it is impossible for the nutritionist to visit each farm and verify the inputs.

Another possible short-fall of the government service program deals with agri-business involved with dairy producers. Financial institutions dealing with producers for example may have the need at various times of the extention person's expertise, but the limits of a government employee's involvement in some of these instances is not clearly defined.

There are numerous sales people on the road these days, selling a wide variety of items to the producer. In most cases these sales staff are trained and know their products well. These reps can offer advice and products to meet the producers' needs. But sales reps derive their living from selling their product and in many cases the producer is left trying to decide whether this product is really what he needs or is the salesman simply trying to make an extra sale?

I sold feed myself for years and I believe most sales people understand that they must be straight-forward with producers if they hope to establish a long-term business relationship with a customer. But there are cases of producers being loaded up with an expensive product he really may not need by a fly-through sales-man or a producer making a one-time purchase of an expensive capital item because he is sold on the idea these will solve his problem only to find he is left with the same and other problems and nothing to show for his money.

On many farms to-day the dairy producer grows the majority of his own feed-stuffs and his only purchases may be a little mineral/vitamens and protein. In cases like this it is not practical for the feed sales person to spend a great deal of time on service work since the $ volume does not warr-nt the time.

For these reasons we feel a need exists for a service providing independent nutrition and management consulting to the dairy industry and businesses dealing with that production industry. While this type of consulting is fairly common-place in the United States, it is a relatively new idea in Canada. I will attempt to describe our service and how it can meet the needs of the dairy industry.

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The service is based on 4 general principles:

1) a service providing frequent, regular contact with the client
2) development of nutrition and management programs suited to the individual's management level, facilities and goals
3) nutrition and management programs based on sound practical and research dairy practises
4) totally independent consulting not aligned to the sale of any particular product

Our service offers no magical solutions in a bag or bottle, simply working on a regular basis with the client to improve his situation.

Although the service has certain features general to all clients I stress the fact that these are flexible programs designed to meet the particular needs of the individual client.

The first visit is usually a fact finding visit. I spend the day with the producer going through his facilities, discussing existing feeding and management practises, determining feed stocks and numbers of various classes of cattle. I also discuss the general operation of the farm in an attempt to focus on any problems the producer may feel he has. The final objective is an attempt to understand the goals of the producer and what type of person I will be working with. This final point is extremely important. Since the producer and I will be working together on a regular basis and my recommendations may be quite different from his existing practises; I believe it is necessary t hat he and I understand one another. At this time I also take samples of all farm grown feedstuffs. I also pick up his milk recording records if available. Using these records we then prepare milk production graphs on each animal in the herd. I find these graphs to be useful in determining weak points in existing practises. Poor heifer management and incorrect feeding for examples are readily apparent using these graphs. Upon return of the feed samples I prepare rations for the milking herd. I currently use computer calculated rations run on IBM PC-XT computer. Usually the milking herd recommendations will involve three separate rations, depending on stage of lactation, since I have found that requirements and intakes vary sufficiently to make this worth-while. Once the rations and graphs are completed I return to the farm and using the graphs, go through

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the herd and mark down the body condition of the animals in various stages of lactation. Again, this has proven useful in determining weaknesses in the existing program. Then using the graphs and new rations, I go through the new program recommendations with the producer. I point out what I believe to be possible problem areas and how the new program will enhance his production. In general the first priority is the milking herd since it is these animals that pay the bills. There-after on monthly visits we up-date the graphs according to milk test weights. About 4 times per year we go through the herd and evaluate the body condition of the cows to determine any unwarranted changes.

Once the producer is on the milking herd program we establish feeding and management programs for the dry cows and heifers. Depending on the producer and his facilities we may tape and measure the young stock and graph these results in order to evaluate the heifer rearing program. Without a doubt heifers and dry cows are neglected on the majority of dairy farms.

A major part of our program is to stress preventative management. In many cases producers make changes and then re-act to the resulting consequences. All producers on the program have had all their feeds analyzed, not just the feed currently being used. In this manner we can balance rations and make management adjustments before the changes take place, rather than simply jumping to put out "brush-fires" as they arise. Doing this we have been able to avoid production drops for example as forages change. We have also been able to maximize economical milk production by adjusting supplementation due to feed changes. In the program we emphasize making the most of home-grown feeds since these are the basis of an economical feed program. In many cases this has meant the producer making changes in his feed management program to better utilize his home-grown feeds.

An important aspect of the program that has developed and surprizes me a little, is acting as liason between the producer and the Manitoba Department of Agriculture. In many cases we have been able to put producers in touch with services offered by the department that producers were not aware of previously. The ag. engineers and the milk equipment testing program are examples of this.

We also encourage producers to keep records on their cows, breeding data and milk

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recording are important tools that must be maintained. We consider a good herd health program worthy of the operator's consideration as well. A vet's sucess rate in any particular case will be higher if he is involved in the herd on a regular basis. Again, we stress total herd management in an effort to maximize returns on the dairy.

Clients that we have fall in two broad categories. The first being producers themselves and secondly ag. industry involved with the producers.

Our producer clients represent the whole gamut of Manitoba dairymen. Herd size ranges from 400 to 14 milking cows. Feeding systems range from total mixed rations to computer feeders to stanchion feeding. Milk production runs from some of the highest to the lowest on the milk recording lists. We have producers that have spent their whole lives on a Manitoba dairy farm and also dairymen newly arrived in Canada from Europe. Because of this wide variation keeping programs flexible is a key to the service. The program developed for a farmer deriving a large part of his income from selling breeding stock could vary significantly from that of a strictly "commercial" dairyman. Again, a feed program designed for an established producer with a good cash flow may be quite different from that of a new producer just starting out.

On e trait though is common to all producers on the feed and management program and that is a desire to improve their operation. To maximize results from the program the client must have this attitude and also the determination to put in the necessary work. Many problems such as long calving interval, high calf mortality or poor milk production can be improved upon by the producer being made aware of the correct techniques and putting them into practice.

The other general category of our clients is industry involved with the producer. In the past we have been utilized by financial institutions and euipment sales companies in an attempt on their part to provide additional service to their customers. This has ranged from general consulting as to how to improve management through to particular advice on how to get the best results from new equipment. In cases like this we have gone in on the firm's behalf in an effort to work with the producer. With the increasing use of computers on farms and the wide variety of programs available, we have done

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work evaluating various programs with an eye to producer use.

Benefits derived by the producer are as varied as the clients themselves. Upon completion of the feed analysis and ration balancing the producer knows he is feeding the cows to meet their requirements. This has generally resulted in increased persistency and higher peak milk production in many of the herds we deal with. A rule of thumb is that for every 1 # increase in peak milk production a producer can expect a 200 # increase in total milk for the lactation. So a 10 # increasea in peak milk could result in 2000 # more milk for that lactation. With milk at about 19¢ per pound, this could generate an extra $380.00 per cow, on a 50 cow herd this would be $19000.00. Often we have been able to reduce feed costs as well. Many producers over-feed their low cows resulting in higher costs with no financial benefit. By feeding their herds correctly many producers are experiancing fewer herd health problems. Numerous metabolic disorders such as milk fever, retained placentas, foot problems etc. can to a large part be prevented through proper feed and management. There are further, possibly less tangible benefits though. As independent consultants we can offer impartial information on new products. In many cases a producer may simply want to discuss long range plans for his operation with someone familiar with the farm. In government extension work it is often found that the producer does not follow the advice offered by the staff. This does not seem to be the case in private consulting. Once the client has paid for the service he demands the information and will most likely follow the program through. One client we have describes the program as his "conscience factor", to keep him on the correct management practises he is aware of,but lets slip now and then.Producers have found that due to our program of frequent contact, the advice we offer is first of all current and secondly, fits into their particular operation.

To industry the private consultant offers a variety of benefits. Mainly having access to a professional specializing in dairy to act as a resource person. The need for this type of person may arise due to problems with a certain customer that the firm may not have the expertise or the time to handle. Also the services of a dairy consultant may be offered as an additional service by various companies. In many cases a company may see the benefits of offering extensive back-up work to its customers but the salary of this type of person can be prohibitive. In these instances a consultant working on a contract basis can be the answer.

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Until now I have discussed mainly the nutrition and management portion of our program. We also offer a service of computerized record keeping.

As mentioned previously the computer age is coming to the farm. However we have to understand the current management on dairy farms to understand how computers may fit in. Regarding herd record keeping many farms keep fairly comprehensive records about milk production, herd health and herd events. But there are far more farms that keep just a bare minimum of records. The same can be said for financial records. So before a farmer can begin to think of a computerized record keeping system he must get into the habit of maintaining those records. Many producers have what I call the "jogger's syndrome". You realize jogging is beneficial but you cannot motivate yourself to get out and do it on a regular basis. So the idea is that you go and buy a $50. pair of runners and a $45. jogging suit, thinking that if you have the proper gear you will do it on a regular basis. Of course you get out two or three mornings then the stuff is left hanging in the closet. Computers in themselves will not make for better records just as those expensive runners won't get you in shape. Therefore producers must be encouraged to start keeping records on a regular basis then consider a computer as a tool to make better use of this data.

While many producers can see some of the benefits of owning a computer, there is hesitation in purchasing the hardware and programs. Firstly, many producers do not know how to choose the correct products. Secondly, there is concern over the continuous erosion of prices. Why buy a computer to-day if it may be hundreds of dollars cheaper tommorow? And thirdly the concern of knowing how to run the thing. In spite of these rservations producers would like the benefits of computers they are constantly hearing of.

Because of this we are offering a custom computerized herd record system. Using a program purchased from Homestead Computers, once a month we go out to the farm and enter the producer's data into the computer. We enter data such as calvings, dry-offs milk weights, treatments etc. and then generate reports the producer requires. While some of this is duplication of the current Dairy Herd Improvement reports the benefits are the information is:

1) more comprehensive
2) more manageable

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3) accurate
4) current, since the producer has all this information with-in a couple of days of his milk test

This is opposed to waiting 2-3 weeks for the return of his D.H.I.A. reports.

We believe this system offers the producer 3 major advantages: he gets a "soft" introduction to the computer and the software, he is certain the data will be maintained and the costs are minimal compared tolaying out cash to buy the package.

The potential for computer use on dairy farms is tremendous. Tha large amount of information that must be stored and processed makes increasd use of computers inevitable. I am no computer specialist but I believe we have just scratched the surface of this potential. Computer link-ups with banks are avalable to the farmer to-day; can similiar link-ups with dairy breed offices and central testing labs be far away?

But as with anything new we will under-go a shake-up of the industry before computers become standard tools of the dairy producer. Currently there are a profusion of programs available; some are good, many are virtually worthless. At the recent World Dairy Expo in Madison Wisconsin there were 9 different types of herd software available. There will probably be a lot of "weeding out" in this area. Many producers will buy computers in the next few years and become extremely irate when this new tool does not perform the tasks they expect. The adage of "first the software then the hardware" should not be forgotten.

In conclusion I would like to come back to the question I am most often asked by potential clients. That is "why should I hire a consultant?" While there can be many answers to this question; the quality of the service, the information provided, the assurance of balanced programs, there is only one feature that really sells a consultant's service. That is results. A consultant's future depends on the results achieved by his clients. All that a consultant has to offer is service and advise, if a consultant's business is to grow and expand he must always bear this in mind.

"ALL IN - ALL OUT" SWINE MANGEMENT SYSTEMS

by Ed Waddell, Regal Feeds Ltd.

To get my talk off on the right foot and to get everyone on the same wavelength, I would first of all, like to give my interpretation of "all in - all out" as it implies to the swine industry. I can visualize someone, not familiar with the system, conjuring up images of loading up some 500 market hogs on the same day and shipping them off to market, similar to the way a flock of chicken broilers would be marketed. Let me assure you, however, that this is not the case in the swine industry. Our packing industry requires animals to be shipped within a very narrow weight range, making this idea totally infeasible.

"All in - all out" simply means that a group of pigs that fills the barn or section of barn is delivered within a short period of time. Pigs are marketed at the correct weight and when they have all been shipped out, the barn or section of barn is cleaned and refilled.

To give you a little history of "all in - all out", I believe most of you are aware that the concept of scheduled depopulation in the intensive production of livestock is far from a new idea. The broiler industry has used this concept for a quarter of a century. The rest of the poultry industry followed close behind and over the last 2½ decades, it has proven to be the most effective and efficient management system.

The swine industry was substantially behind the poultry industry, however, some ten to twelve years ago we saw the humble beginnings of "all in - all out" in hog barns. Although one couldn't help but be awed by the grandeur of a 300 sow farrowing room with some 60 crates all in one room, it became evident that no matter how careful an operator was, he was going to end up with disease related problems in his farrowing facility. So finally emerged the "all in - all out" farrowing-nursery facilities along with raised flooring. This innovation to be probably the single most effective factor in improving productivity in sow operations in recent years.

Since the modern farrow-nursery facilities are approaching state-of-the-art; and principles of "all in - all out" have been accepted by the industry, I would like to concentrate my talk on the final phase of "all in - all out" in the swine industry. That is the batching of growing and finishing pigs in some form of isolation.

I personally began thinking along these lines some seven or eight years ago. At that time, as now, we had lots of problems with all the different forms of pneumonia. I remember, in particular, a conversation I had with a young farmer named Roger Thibault. He had recently completed the building of a farrow-nursing barn that would still be considered modern today. Our observation was that pigs were coming out of his nursery barns basically unaffected by pneumonia, were thrown into the big disease pool of his feeder barn and sometime between then and marketing, too many pigs were being

affected by pneumonia in the form of mortality, slower growth and presumably poorer feed conversion. We knew at that time we had to figure out some economic, practical way to keep the newly received younger pigs from the disease ridden, foul air of the older pigs which was highly concentrated with pneumonia organisms.

This idea stayed with me with no action until about three and a half years ago when I had the privilege of being a guest of Elanco Animal Health Division, who gave me a personal tour of some of the large integraters of Quebec. I basically saw working exactly what I thought could work. It was then a matter of adopting the idea so that it would also work in our free enterprise (non-integrated) systems of the West.

To make the idea work without integrating, we formed a group of interested weanling producers. The weanlings from each one of these production units are picked up on a weekly basis, all pigs weighing between 38 and 45 pounds. On the other side of the coin we have a group of feeder barn operators who have scheduled fill up dates. By the time we have filled the last barn on the schedule, the first barn has been emptied and is ready to be filled again. (Figure 1)

Next, I would like to talk about some of the facilities that have arisen as a result of the "all in - all out" concept. Let me stress however, that nobody has built the perfect hog feeder barn yet, but we're still looking.

The four basic types that seemed to have emerged as of this point in time are:

1) Totally "all in - all out" (Figure 3)
2) The split-shift (Figure 4)
3) The split-carry over (Figure 5)
4) Multiple age barn (Figure 6)

1. TOTALLY "ALL IN - ALL OUT" (FIGURE 3)

DESCRIPTION: As the name implies, all the pigs are put into the barn, grown out, and are marketed at correct weight. After they are all sold, the barn is cleaned and a new batch put in again.

ADVANTAGES:
- total clean out between batches and therefore the least chance of carry over of disease from batch to batch;
- easy management - fill and empty three times a year;
- no moving of pigs until shipping.

DISADVANTAGE:
- lower turn over per year.

2. SPLIT SHIFT (FIGURE 4)

DESCRIPTION: Pigs are put into side 1 for half the time then moved to side 2. Side 1 is then cleaned and a new batch received.

ADVANTAGE:

- better utilization of barn space.

DISADVANTAGES:

- more management (shipping, receiving pigs every 2 months);
- a chance of cross contamination between batche 1 & 2 (in spite of air lock utility room);
- the whole system still depends on the slowest pigs in the barn, (in other words a new batch cannot be put in until the last group in Batch 1 has been shipped).

3. SPLIT CARRY OVER (FIGURE 5)

DESCRIPTION: The full compliment of pigs put in at once; when 70% of the pigs have been shipped, the remaining 30% go into side 2 and a full batch is put into side 1 again. In due course side 2 is marketed at correct weight and side 1 is split on a 30 - 70% basis.

ADVANTAGES:

- easy management (three groups a year);
- good turn over of pigs since you are not held back by the slowest 30%.

DISADVANTAGE:

- slightly more moving and mixing of pigs.

4. MULTIPLE AGE BARNS (FIGURE 6)

DESCRIPTION:

- six rooms;
- pigs are put into pens where they stay until market;
- a room is filled approximately every 3 to 3.3 weeks.

ADVANTAGES:

- more even cash flow;
- virtually continuous shipping, so more likely to get an average market price;
- no moving of pigs until shipping.

DISADVANTAGES:

- poorer utilization of barn space;
- increased chance of cross contamination from room to room;
- increased management filling every three weeks and shipping virtually every week;
- entire flow of pigs subject to the slowest growing group;
- much harder to do a performance analysis;
- unless you had a separate bin for each room you could not phase feed or you would have to feed by cart;
- because of more spread out shipping you may or may not lose out on the advantage of shiiping larger loads, i.e. freight costs.

ADVANTAGES OF "ALL IN - ALL OUT" SWINE MANAGEMENT SYSTEM

1) Accurate records
2) Break in the disease cycles
3) Phase feeding program
4) Safe and effective use of drugs
5) More streamlined management
6) Larger and/or more uniform loads to market
7) Chance to clean up the barn completely three times a year

ADVANTAGES

1) Accurate records on each and every batch of pigs that go through the barn

This possibility is by far the most important advantage. If there was no other advantage at all, this one alone would justify, in my mind, going to this system. Almost three times a year the hog farmer knows how much he made or lost per pig, he knows his feed conversion, his growth rate, his mortality, his index, and his average shipping weight. Knowing these facts he can compare with the average of others on the same program; he can pick out weak areas and correct them for the next batch.

As an observer of how these facts can work to improve efficiency, we have seen, for example, that floor feeding always

takes more feed per pound gain, takes longer to market, produces more uneven growth among pen mates. We were able to show producers who were averaging 210 lbs. shipping weight how much they were losing by not keeping them to average 220. Feed programs have been analyzed quickly and easily by monitoring f/c and growth rates.

2) Break in the disease cycles

As mentioned earlier pneumonia is one of the primary disease agents causing losses to hog farmers today. Most pneumoniae can be eradicated by depopulation for relatively short periods of time.

3) Feed program

Instead of having one feed to supply the needs of pigs 40 lbs. to 220 lbs., a phase feeding program can be developed to meet the needs of the pig at any particular size.

4) Safe and effective use of drugs

We eliminate the problem of withdrawal of antibiotics, since no pigs are shipped until the last month of the cycle. This has been a major problem in multiple age barns, as pigs must be held back from market while treating plus the withdrawal period. As a result multiple age pigs get treatments for a much shorter period of time than recommended, pigs are shipped much over or underweight, or, proper withdrawal is not observed. "All in - all out" solves this problem.

5) More streamlined management

A farmer puts out more effort when weanlings are first delivered and when marketing, but between these times, management becomes very simple. Things like getting the water medicator out every week to receive pigs and weighing pigs every week are a thing of the past.

6) Larger and/or more uniform loads to market

This may or may not be an advantage, depending on the situation. To a fellow who is running at maximum efficiency and doesn't have time to run to the city with a half ton load of pigs every week, I would say it's an advantage.

7) Chance to clean up the barn completely three times a year

Let's face it, it is almost impossible to clean a continuous flow barn. This has to be an advantage to the pig, the barn, and the mental attitude of the operator.

DISADVANTAGES

1) Possibly poorer utilization of floor space because each pig requires the space of a market pig. Any offsetting improvement in growth rate, however, compensates for this. The split shift and split carryover systems also decreases this disadvantage.

2) Less even cash flow is another factor to be concerned with; however turkey people who also operate on an approximate 20 week cycle have managed for years. Further, by using 30 day accounts correctly, the interest one pays going from nil to maximum in a 4 month period is probably little more than an average debt on a continuous basis. Again the split systems further reduces the fluctuation.

3) Slightly more power will be used to heat the barn when weanlings are put in during cold weather. Keep in mind, only one out of three batches go in during the very cold weather. This cost amounts to very little per pig.

In conclusion, I'll throw out a few of the results we have been seeing over the last year or so. I'll be the first to admit that we've seen more variation than I'd like to see. But I think that the big advantage we have now, is that we can study each herd on an individual basis. We have the possibility of pointing out to the operator what we feel he could do to improve his profitability. We also have the opportunity to look at our own feeding program and make adjustments as the results come in. (Figure 7)

Fig. 1

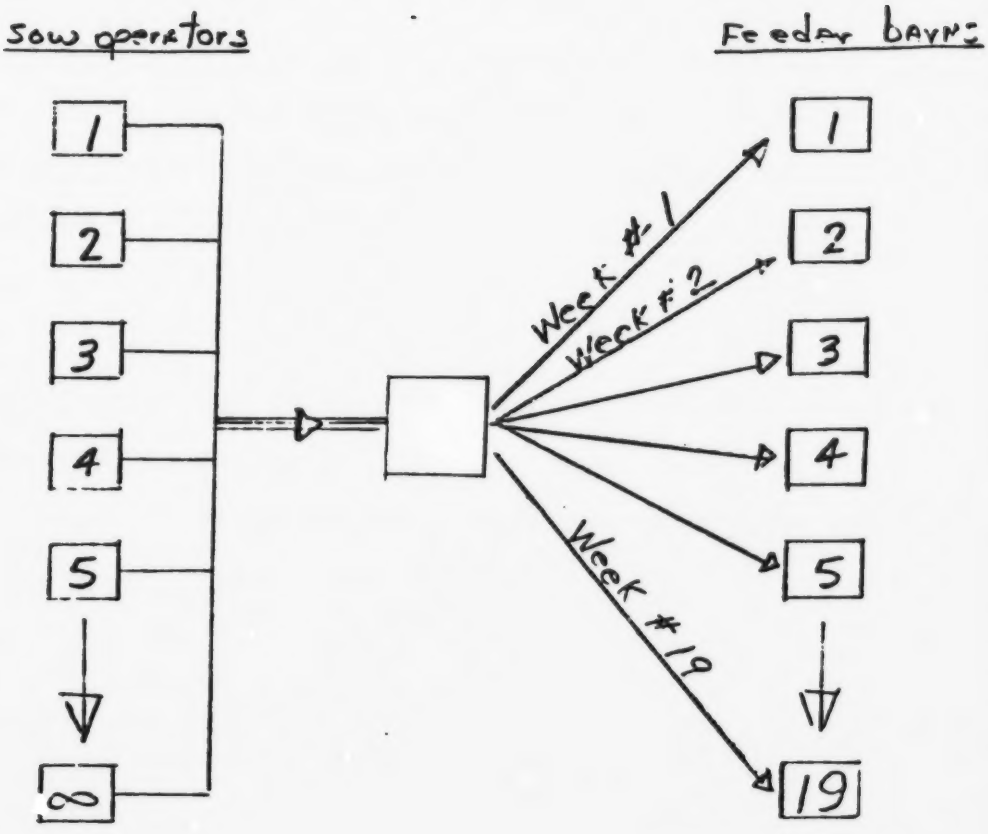

Sow operators
Feeder bays
1
2
3
4
5
∞
Week #1
Week #2
Week #19
1
2
3
4
5
19

FIGURE 2

1) TOTALLY "ALL IN - ALL OUT"

2) THE SPLIT-SHIFT

3) THE SPLIT-CARRY OVER

4) MULTIPLE AGE BARN

Fig. 3

Totally All-in All-out

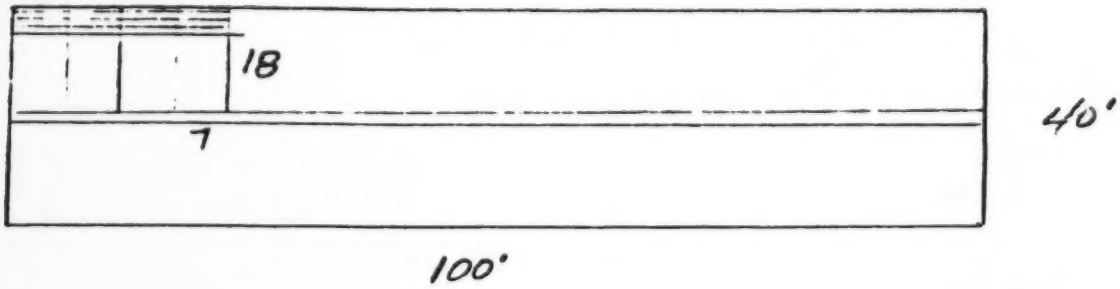


Fig. 4

Split - Shift

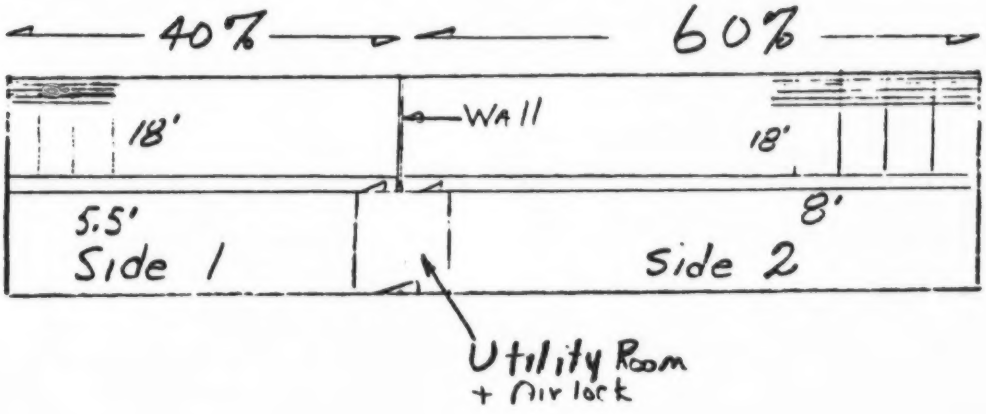


Fig. 5

Split – Carry over

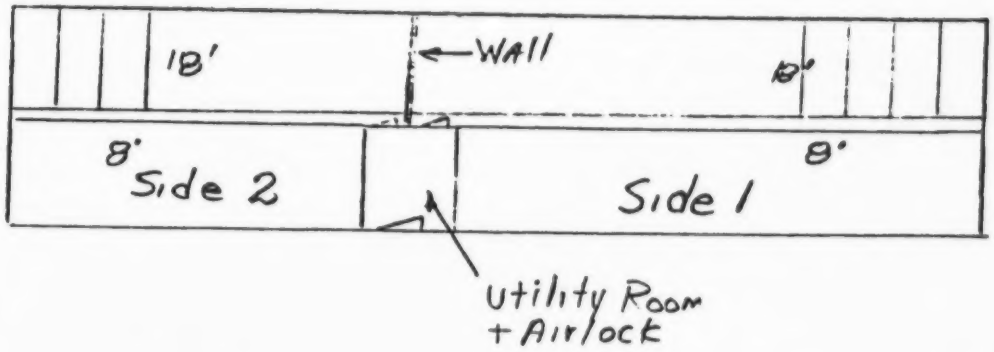


Fig. 6

Multiple Age

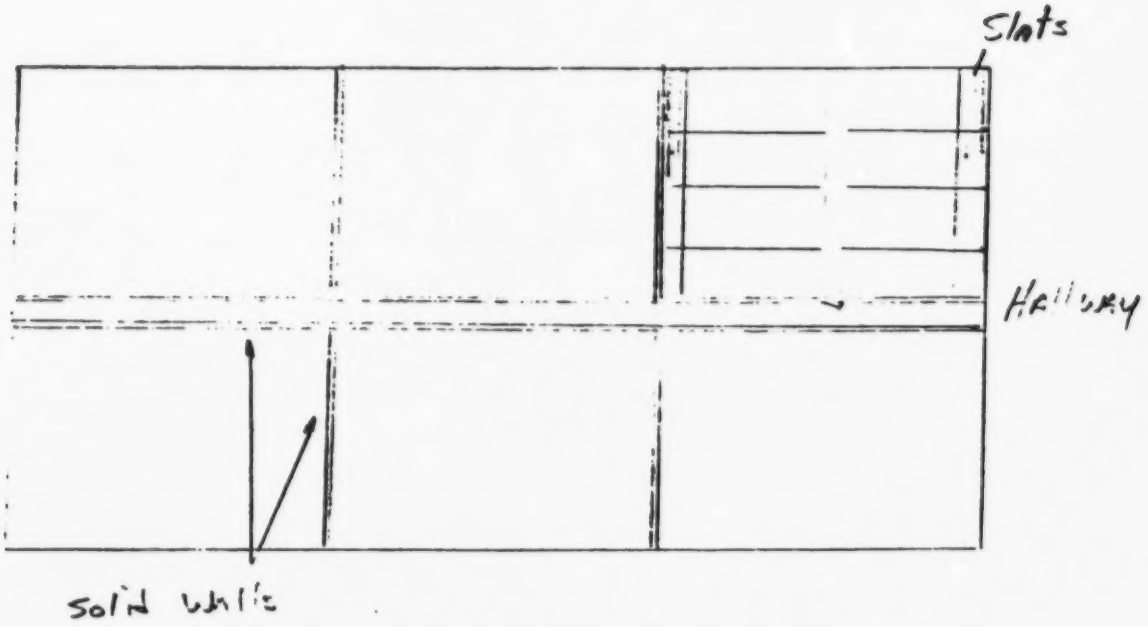


FIGURE 7

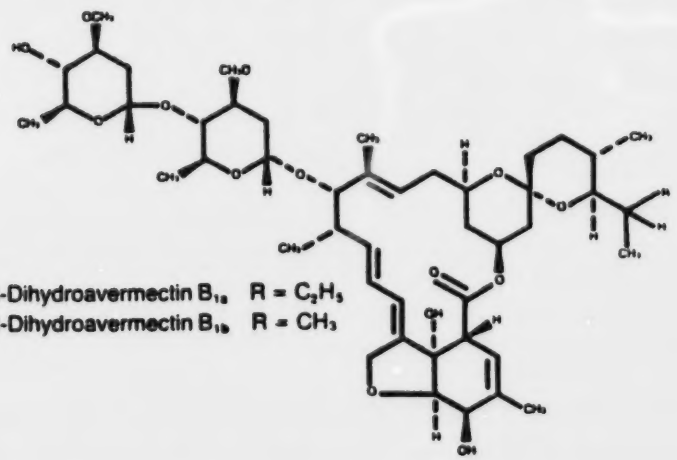
		AVG.	HIGH	LOW
INDEX		103.2	107.7	101.6
MORTALITY		4.37	6.5	1.3
GAIN/DAY		1.26	1.68	1.19
FEED CONVERSION -	All Barns	3.42	3.87	2.94
FEED CONVERSION -	Self Feeders	3.30	3.43	2.94

THE AVERMECTINS - THE DAWN OF A NEW ERA

The avermectins are a new family of antiparasitic products developed by Merck Sharpe & Dohme Laboratories. These avermectins, which have a unique mode of action against a broad spectrum of nematode and arthrapod parasites, had an interesting beginning.

The independant Kitasato Institute in Japan was contracted by MSD Research Laboratories to search for products with biological activity. Thousands of soil samples were cultured and analysed until one, in which Streptomyces avermitilis, was isolated in 1976, and proved to be lethal to worms and some arthropods exposed to it. The dawn of a new era began. It is the first product with ability to control both endo and ectoparasites at the same time.

At present, ivermectin is the first in a series of anti-parasitic agents derived from the avermectin family. Ivermectin consists of a pair of homologues differing only by a methyl group (CH_2). Ivermectin consists of not less than 80 percent of B_{1a}, not more than 20 percent B_{1b}.



22, 23-Dihydroavermectin B_{1a}, R = C_2H_5
22, 23-Dihydroavermectin B_{1b}, R = CH_3

As you can see, Ivermectin has a unique chemical structure unrelated to any present compound, and this is important in so far as resistance is concerned. It has a unique mode of action. The mode of action is to paralyse and ultimately kill susceptible parasites. This paralysis is brought about by the release of a substance called gamma aminobutyric acid or GABA, which inhibits the transmission of the nerve impulses to the motor system of the parasite, ie. the system that allows the parasite to move. As a result of the loss of command of their movement, the parasites are unable to feed and therefore die. They are then either excreted through the feces if they are located in the digestive system or eliminated by other defense mechanisms when located elsewhere (in the blood or skin for example).

Ivermectin does not exhibit measurable activity against flukes and tapeworms, presumably because they do not have GABA as a nerve impulse transmitter.

Internal and external parasites cause various types of damage to the respective animal species, but they share one common denominator - economic loss to the farmer.

At present, there are four commercial products available to livestock producers. They are as follows;

Ivomec Injection for Cattle
Ivomec Injection for Swine
Ivomec Drench for Sheep
Eqvalan Paste for Horses

Ivomec injection for cattle is efficacious against;

1) Adult and immature gastrointestinal roundworms
2) Adult and immature lungworm
3) All parasitic stages of the warble fly
4) Sucking lice
5) Mange mites.

The recommended dosage is 1cc/50 kg given subcutaneously, under the loose skin in front of or behind the shoulder. It is safe to use Ivomec in calves, bulls and pregnant cows. The withdrawal period is 35 days. It cannot be used in lactating dairy cows and, non-lactating dairy cows should be treated 60 days prior to calving.

Ivomec injection for swine is indicated for the treatment of the following parasitic infestations of swine;

1) Gastrointestinal roundworms
   - Large roundworm
   - Red stomach worm
   - Nodular worm
   - Thread worm
2) Lungworms
3) Lice
4) Mites

The recommended dose is 1cc/33 kg of BW. by subcutaneous injection in the neck. It has a wide safety margin in swine as it can be used in boars, growing pigs and pregnant sows at any time during the gestation period. The withdrawal period in swine is 28 days.

Ivomec Drench for sheep is a ready to use liquid suitable for oral administration. It is indicated for the treatment of the following parasitic infestations in sheep;

1) Adult and immature gastrointestinal roundworms (including known benzimidazole-resistant strains)
2) Adult and immature lungworm
3) All larval stages of the nasal bot

The recommended dose is 2.5cc/10 kg of BW. given orally. It is safe to use in lambs, breeding rams and pregnant ewes. The withdrawal time in sheep is 14 days.

Eqvalan paste for horses is available in a ready to use calibrated syringe. Eqvalan paste is indicated for the treatment of parasitic infestations due to;

1) Large strongyles
2) Small strongyles
3) Pinworms
4) Ascarids
5) Hairworms
6) Neck Threadworms
7) Stomach Bots.

Eqvalan paste is the only horse dewormer which kills the migrating larvae of the Strongylus vulgaris which cause 90% of all colics in horses. Each syringe treats 500 kg of BW. and is safe to use in foals, stallions and pregnant mares. Eqvalan is available through veterinarians only.

. The ivermectin products are convenient, broad-spectrum and have a wide safety margin. More research is being done with the avermectin family of compounds, and you can look forward to new products in the near future.